THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE III. VOL. V.

No. IX.—SEPTEMBER, 1888.

ORIGINAL ARTICLES.

I.—On a New Species of *Æger* from the Lower Lias, of Wilmcote, Warwickshire.

By Henry Woodward, LL.D., F.R.S., V.P.G.S.,
of the British Museum (Natural History).

(PLATE XI.)

THE genus *Æger* of Münster was established in 1839, to contain some of the most beautiful forms of Prawn-like Crustacea found in the Solenhofen Limestone of Bavaria (see Beiträge, vol. ii. p. 64). Dr. Oppel, in his Palæontologische Mittheilungen (Stuttgart, 1862), p. 109, thus defines the genus:

The inner antennæ (antennules), with their long bifid filaments, start from three strong basal articulations, and attain in most specimens to twice the length of the whole body. The antennal scales are thin and very long. The basal joints of the inner antennæ are finely serrated along their border. They are much elongated, and project further in front of the head than the outer antennæ, as is the case in the existing Shrimps.

The rostrum of the cephalothorax forms a long and slender spine with several small tubercles along the sides. It may even attain the length of the cephalothorax. These characteristics may not however all be constant in the genus *Æger*.

The outer maxillipeds or jaw-feet are of great length, and are furnished on either side with a row of slender moveable spines of considerable length. A very small spine usually springs from the base of each of the larger spines. The first three pairs of true thoracic feet are chelate at their extremities, and are also partially covered with similar moveable spines.

The first pair of chelipeds are the smallest, the second are somewhat larger, whilst the third pair are always the largest.

The fourth and fifth pairs of legs are monodactylous, and are generally very long and slender, but vary in different species.

The surface of the whole of the integument is thin, but very finely granulated, even the caudal plates displaying this character.

The form of the abdomen furnishes no marked peculiarities. The false abdominal feet with their basal articulations are frequently preserved. The outer caudal lamellæ are divided diagonally by a line of articulation near their distal extremity.

Through the kindness of the Rev. P. B. Brodie, M.A., F.G.S.,

Rural Dean, and Vicar of Rowington, near Warwick, I have received a block of Lower Lias Limestone from the "Insect-bed" (*Ammonites planorbis*-zone) at Wilmcote, containing a very well-preserved specimen of a Macrourous-Decapod Crustacean referable to the genus *Æger* of Münster.

The specimen was obtained by the Rev. H. E. Lowe, M.A., residing at Wilmcote, who procured it from one of the quarrymen, and afterwards generously presented it to Mr. Brodie.

Like similar fine-grained fissile limestones, such, for instance, as the Lithographic Stone of Solenhofen in Bavaria, these Lias beds divide up into more or less numerous layers, the fossil-remains being exposed as impressions and counterparts, upon the corresponding surfaces of the slabs when split along their laminæ. In this instance, however, only the single slab containing one side of the organism, has been preserved, so that some parts of the surface of the body-segments and appendages, which had adhered to the counterpart, have been lost with it.

The specimen, which is of the bigness of an ordinary-sized prawn —the body being $4\frac{1}{2}$ inches in length—is lying upon its left side.

Its rostrum, which is not serrated, is exceedingly slender, and as long as the entire carapace. The right ophthalmite, and its peduncle, are very well preserved. Only traces of the first or inner pair of antennæ can be detected; but the outer antennæ, with their long multiarticulate filaments, can readily be observed, together with the prominent spine near the base of the same that gives support to the long oval antennal scale, the impression of which can also be clearly made out. Next is seen a pair of extremely long spinigerous maxillipeds, with simple non-chelate extremities, their four distal joints armed with two rows of long, sharp, and slender articulated spines arranged at regular distances apart along each border.

Next follows the first pair of walking-legs, which are slender and shorter than the maxillipeds, and are provided with chelate terminations. The second pair of legs are also chelate, and similar to the first. The third pair are broken off near the body. The fourth and fifth pairs of limbs are long and very slender, and have likewise simple monodactylous terminations.

The carapace is twice as long as it is deep, its surface smooth, and, where preserved, of a rich brown colour. Just over the branchial region the carapace (*branchiostegite*) is wanting and we see exposed the vertical ridges of the calcified endophragmal system, consisting of the infoldings of the lateral walls of the thorax, to which the legs are articulated, and which give attachment to the muscles of the limbs, and upon the outer face of which, but covered by the over-arching branchiostegite, the branchiæ or gills were situated.

The specimen measures 106 millimètres in length by 40 mm. in depth, and displays the cephalothorax 53 mm. long by 20 mm. in depth, the rostrum being 24 mm. long, the pedunculated ophthalmite 4 mm. long.

Behind the cephalothorax are seen the six abdominal segments of nearly uniform size, the last supporting the 'telson' or terminal

joint, which is slender and pointed, and has the caudal lamellæ of the 6th segment lying close beside it; the outer one of which is marked by a transverse articulation near its lower extremity. The false abdominal feet, with their basal joints and their bifid multiarticulate appendages (exopodite and endopodite), are also clearly seen.

In 1866 I described a new species of *Æger* from the Lias of Lyme Regis, Dorset (see Geol. Mag. 1866, p. 10, Pl. I.). This specimen, which I named *Æger Marderi*, is much larger, and altogether more robust, with shorter and stouter limbs than that now under consideration. Mr. Brodie's specimen is not only smaller, but the limbs are much longer and more delicately slender.[1]

Having many beautiful examples of these elegant Crustaceans from Solenhofen now before me (part of the grand collection formed by Dr. Haberlein, and purchased of him in 1863 for the British Museum), I have been able to study and compare this fossil from Wilmcote with these, and also with that from Lyme Regis referred to above, and I am of opinion that it is specifically distinct from all these, although the species have, as a whole, a well-marked generic facies. I propose, therefore, to name this form *Æger Brodiei*, in honour of my valued geological friend, the Rev. P. B. Brodie, whose labours in the Liassic beds of Warwickshire and elsewhere, extending over half a century, have resulted in a large accession of interesting and beautiful Arthropoda to the Liassic Fauna of Britain.

II.—The Jordan-Arabah Depression and the Dead Sea.

By Israel C. Russell,

Of the United States Geological Survey (Appalachian Division of Geology), Department of the Interior, Washington, D.C., U.S.A.

(*Concluded from the August Number*, p. 344.)

Lacustrine History of the Dead Sea Basin.

THE occurrence of numerous terraces on the mountain slopes overlooking the Dead Sea has been reported by several observers, but no accurate measurements of their elevations or definite correlation of the terraces on the opposite slopes of the depression, seem to have been attempted. In the central part of the Wady Arabah on the west flank of the promontory known as Samrat el Fedan, a terrace, or perhaps more properly a gravel bar, has been observed by Hull[2] at an elevation of about 1300 feet above the Dead Sea. This is apparently a definite record of the surface level of the Dead Sea during a former period. On the sides of the Jordan valley the terraces range in height from a few feet to 750 feet above the river. The measurements reported show great variation due principally to an inclination of the surfaces of the terraces, towards the centre of the valley, but indicating also that they are not horizontal in the direction of drainage. The terraces of the Jordan valley, although

[1] In describing the Lyme Regis fossil, I erroneously spoke of the long spinigerous maxillipeds as the first pair of thoracic legs.

[2] Geol. and Geog. of Arabia Petræa, Palestine, etc., page 87.

usually referred to as lake terraces, seem to admit of another interpretation.

The Dead Sea basin has been deeply filled, especially in its northern and southern portions, by lacustrine sediments, supplemented by gravel and sand washed from tributary valleys and neighbouring alluvial slopes. It seems probable that these deposits filled the basin from side to side in the Jordan valley and in the Wady Arabah, but not so completely as to form a level floor throughout. When the waters of the ancient lake fell to a lower level than the surface of the sediments in question, the Jordan flowing from the north and the Jeib from the south, toward the Dead Sea, cut channels in the previously formed deposits. Pauses in the lowering of the lake surface would establish a base level of erosion for the inflowing streams, thus allowing them to widen their channels, so that when another lowering of the lake occurred and the streams re-commenced the excavation of their channels, a terrace would be left on the sides of their valleys. These terraces would slope with the grade of the streams which formed them, and on reaching the Dead Sea basin, would unite with the horizontal terraces formed by the waters of the inclosed sea.

This interpretation of the history of the terraces of the Jordan valley is strengthened by the following observation recorded by Hull in the narrative of his journey of exploration.[1] "All these terraces (along the Jordan near Jericho), excepting perhaps the upper, have doubly sloping surfaces, both toward the centre of the valley and toward the Salt Sea. The upper terrace only slopes toward the centre of the valley, as its upper surface corresponds almost exactly with the terrace of Jebel Usdum, and the other old sea margins, near the southern end of The Ghôr."

Sections of the material filling the Wady Arabah near the steep descent to the plain of the Dead Sea show fine lacustrine sediment at the base, passing into sand and gravel in the upper portion. The surface of this deposit rises when followed southward or up the valley, but breaks off abruptly, as mentioned above, in a steep escarpment about six hundred feet high at the north, facing the depression now holding the Dead Sea. The structure of this deposit so far as known, as well as its topographic form, suggests the probability that it is of the nature of a delta, the steep lakeward scarp of which has been cut away by the waves and currents washing its base. A similar interpretation will apparently apply in many ways to the facts reported concerning the material filling the Jordan valley. A detailed study of these deposits is required, however, before the mode of their formation can be definitely determined.

Lake beds are mentioned by Hull, and others, as existing not only in those portions of the basin adjacent to the Dead Sea, but at high altitudes near both the northern and southern portions of its basin. In Wady Arabah fine, evenly stratified lacustrine sediments charged with freshwater shells, were observed at an elevation of 1400 feet above the present surface of the Dead Sea.[2] In the same

[1] "Mount Seir, Sinai and Western Palestine," p. 162.

[2] Geol. and Geog. of Arabia Petræa, Palestine, etc., p. 80.

basin, near the Sea of Galilee, about 175 miles to the north of the locality mentioned above, other lake beds have been observed at about the same level. These observations, and others of a similar nature which might be cited, show very clearly that the Dead Sea basin was once occupied by a freshwater lake, whose bottom at certain localities was 1400 feet higher than the present surface of the Dead Sea, or at about the level of the Mediterranean.

The surface of this lake during its greatest expansion must necessarily have been at a higher elevation than the deposits accumulated on its bottom, but unless the beach observed by Hull in the Wady Arabah, of which mention has already been made, indicates the level of the ancient lake during the time the lacustrine sediments were deposited, we have no observations of shore records that can be correlated with the formation of the higher sedimentary deposits. Providing no change has taken place in the depth of the Jordan-Arabah depression since this great freshwater lake deposited its high-level marls, it must at one time have been about 2700 feet deep. Its length from north to south probably exceeded 200 miles, its average width being from eight to nine miles. Its full extent cannot be definitely known, however, until its shore records have been studied and their extent accurately mapped. Its depth is also uncertain, and has possibly been considerably overestimated, as will appear on the following page.

The existence of calcareous tufa on the terraces of the Jordan and in the lower portions of the lateral gorges opening into The Ghôr, as observed by Johnson and Lartet, show that calcium carbonate was among the first precipitates thrown down by the waters of the ancient lake. The presence of freshwater shells in these tufas is to be expected, as such deposits may be formed from the waters of lakes that are essentially fresh. Future observers should also look for alternations of various varieties of tufa, for the reason that varying deposits of this character record changes in the chemistry or perhaps variations in the temperature, of the water from which they are precipitated.

Near the southern border of the Dead Sea, at a locality called Jebel Usdum, or Salt Mountain, there is a well-marked terrace, the surface of which has an elevation of about 600 feet above the Dead Sea, and corresponds with the level of the escarpment previously mentioned farther to the south. It is also represented on the east side of the valley, as well as near the mouth of the Jordan. The detached portions of this terrace, which is the most pronounced of any in the basin, mark the boundaries of the profound gorge known as The Ghôr. The escarpment at Jebel Usdum exposes the edges of horizontal strata and owes its precipitous character to the removal of the eastern portion of the deposit. In this respect it corresponds with the escarpment at the south end of The Ghôr. The lower portion of the cliff at Jebel Usdum consists of a layer of rock salt from 30 to 50 feet thick, resting on beds of gravel, shales and laminated sandstone.[1] Above the stratum of salt are some 400 feet of evenly-bedded

[1] Mount Seir, Sinai, and Western Palestine, p. 131.

calcareous marls, with gypsum. H. C. Hart, the only observer who has ascended Jebel Usdum, reports that the salt appears to cease at about 100 or 150 feet, and that the remainder of the elevation is composed of white powdery marl.[1] These observations apparently leave no doubt that this deposit, as concluded by Hull, was formed during a previous stage in the history of the Dead Sea, and that it is synchronous with the lacustrine beds exposed in the escarpment south of the Dead Sea, in the Lisan (the peninsula at the south-east border of the Dead Sea) and in the Jordan valley.

It is evident, therefore, that the stratum in question records a period of long duration, during which the water of the lake was a saturated brine, from which sodium sulphate and sodium chloride were precipitated. The marls and clays resting on the saliferous strata show that the lake subsequently became less salt, and at the same time rose to a higher level. It follows from this that the strata of salt and gypsum must have been deposited during a period of concentration intervening between two high water stages. In order to prove or disprove this inference, search should be made in other portions of the basin for lacustrine beds belonging to two high water stages, separated by beds of gravel and other debris indicative of a period of low water. An unconformity between the upper and lower lake beds due to the erosion of the lower member during an intervening period of desiccation should also be looked for. The record of a period of low water is perhaps indicated in a section of lacustrine deposits exposed on the east side of the Dead Sea, which has been described and figured by Lartet,[2] but this observation is not sufficiently definite to enable one who has not visited the locality to make a full interpretation of its meaning.

As the Dead Sea now has a maximum depth of 1278 feet, and the surface of the terrace at Jebel Usdum is 600 feet above its surface, it follows, providing there has been no orographic change, that the ancient lake after the deposition of the salt bed must have been more than 1900 feet deep and greatly expanded beyond its present limits. The concentration of so great a body of highly saline water to less than two-thirds its original volume, as would have been the case had its contraction to the present limits of the Dead Sea been the result of increased evaporation simply, would have produced such a vast precipitation of sodium chloride and other salts that one would expect to find abundant records of the occurrence, had it taken place. The absence of such deposits is negative evidence which apparently indicated that the entire sea was never sufficiently saturated to precipitate saline matter, or else that an important change has been made in the depth of its basin since the salt bed at Jebel Usdum was deposited.

Two other hypotheses present themselves in this connection, each of which seems worthy of attention.

[1] The strata composing the cliffs at Jebel Usdum, however, are considered by Lartet as being of even older date than the origin of the Dead Sea basin.

[2] Expedition géologique de la Mer Morte, Paris, 1877, pp. 175–176, pl. 3, fig. 3; also in Essai sur la géologie de la Palestine, Paris, 1869, p. 240.

The first hypothesis is that the strait separating the Lisan peninsula from the west shore of the Dead Sea was formerly contracted so as to partially shut off the southern end of the lake from the main water body, and that evaporation in the restricted basin thus formed was greater than the amount of water contributed to it by streams and springs. The result of these conditions would be an influx of water from the main or northern water body and a deposition of salt in the partially inclosed southern basin. If this process continued for a considerable time, a heavy deposit of salt would result, which might become buried beneath lacustrine marls when an increase in humidity caused the two basins to unite. In this manner the great deposit of salt along the south-west border of the Dead Sea with its covering of marl, as well as the absence of similar saline deposits in other portions of the basin, can, apparently, be accounted for.

The sequence of events here postulated is suggested by the topography of the shores of the Dead Sea. As indicated on the maps accompanying the reports of the U. S. Expedition, the strait referred to in the above paragraph is two miles wide and from twelve to eighteen feet deep. The area south of this contraction, and now partially shut off from the main body of the Dead Sea, has a surface sixty square miles in extent. If this basin should be filled to the horizon of the highest salt deposits at Jebel Usdum, its area would probably exceed a hundred square miles. A contraction or filling of the strait connecting the two divisions of the sea, as suggested above, possibly by the construction of embankments across it, would initiate conditions similar to those now to be observed on the east shore of the Caspian, where a gulf known as the Kara Bugaz furnishes an evaporating basin for the waters of the main sea. In this instance the amount of water reaching the Kara Bugaz annually through streams and springs, etc., is much less than the mean annual evaporation from its surface, consequently a current flows continually from the Caspian into the gulf. Owing to these peculiar conditions a precipitation of salt is taking place from the highly concentrated waters of the gulf, while the main water-body contains only a small fraction of one per cent. of saline matter in solution. Should the Caspian rise a few hundred feet, the Kara Bugaz would have free communication with the main sea, and the beds of salt in its bottom would become covered with lacustrine sediments, probably charged with freshwater shells. The record thus produced would be essentially the same as the section now exposed on the south-west border of the Dead Sea.

The second hypothesis is that the Dead Sea basin throughout was far more shallow than at present at the time of the deposition of the rock salt and gypsum on its south-west border, and that subsequently it rose sufficiently to bury these deposits beneath lacustrine sediments. After this rise a movement took place along the Jordan-Arabah fault and deepened the basin; or, it may be suggested, that the change was due to the subsidence of an orographic block situate beneath the Dead Sea, and included between the main fault and a secondary fracture branching from it. At a later date the

waters of the lake were again concentrated, and the present condition of the basin resulted. These changes must have been accompanied by many minor oscillations of humidity, and consequently by many changes of lake level; which were accompanied in turn by many variations in the character of the precipitates thrown down from the lake waters.

A deepening of the central depression in the manner postulated would not only lower the lake surface without forming saline deposits, but would enable its waves to erode the surrounding shores and form cliffs in the previously formed sedimentary beds, like those at Jebel Usdum and ed Debbeh. The lowering of the Dead Sea would also allow the inflowing streams to cut terraced channels through the previously formed lacustrine sediments, its effect being in this respect essentially the same as the lowering of the lake surface by evaporation.

The effect of a movement along the Dead Sea fault of the nature we have suggested, on the history and condition of the Sea itself, renders the study of this displacement of unusual interest. In this connection it is desirable not only to have observations on fault scarps in lacustrine marls and clays and in alluvial deposits if such exist, but we desire also accurate measurement of the elevation of the principal terraces and beaches on the borders of the Dead Sea and in the Jordan valley. Three lines of level run from the Dead Sea surface up the borders of its basin on both the east and the west, to beyond the highest of the ancient lake records, and so located as to cross the best-defined terraces, besides two or three cross-sections of the Jordan valley showing the elevation of the terraces there existing, would give sufficient data both in reference to east and west and north and south axes, for determining if recent orographic movement has taken place in the Dead Sea basin or not. The lines of level suggested could be connected with the soundings of the Dead Sea, and thus give accurate profiles of the basin.

Certain writers have considered that the Jordan-Arabah depression was formed in Tertiary times beneath the ocean, and that when the land rose, the basin was occupied by ocean water. So far as we are aware, no evidence of sediments containing marine fossils has been found in the basin. It has been argued in this connection, also, that the fauna of the Sea of Galilee must have been derived from the ocean, being entrapped in the valley at the time of the emergence of the land.

That the fauna of the Dead Sea basin is specialized, and differs from the faunas of neighbouring drainage areas, is not a fact peculiar in itself. On the contrary, an insular fauna is to be looked for in any basin that has been cut off from oceanic drainage for a long period.

It seems to the writer that there are sufficient facts to indicate that the Jordan drainage was once connected with other river systems, but has been isolated sufficiently long for its fauna to undergo an independent development, and thus become differentiated from the life of neighbouring rivers. Space however will not admit

of our presenting more than a suggestion of the arguments which might be advanced in this connection.

From a study of the fishes of the Jordan drainage system, Günther[1] concluded that "The system of the Jordan presents so many African types that it has to be included in a description of the African region as well as the Europeo-Asiatic." A similar conclusion has been advanced by Tristram in his great work on the Fauna and Flora of Palestine.[2] This evidence, so far as it goes, is certainly on the side of a former connection of the Jordan with other drainage systems.

Besides the facts furnished by the fauna of the Jordan drainage system in reference to a former connection with other drainage areas, we have physical evidence bearing on the same question.

The Jordan-Arabah depression receives tributaries from the east and west through deeply eroded stream channels, which were cut to their present depth before the occupation of the basin by the lake which deposited sediment over so large a portion of its area. The fact that these tributary channels were cut before the existence of the lake, the sediments of which partly fill them, is in itself sufficient proof that the basin at one time had free drainage. The present topography of the basin indicates that the ancient drainage was southward through the Gulf of Akabah, but other outlets to the sea may have existed at various times during the earlier portions of its history. One of these, it may be suggested, may have been situated at the Pass of Jezreel, at present the lowest point in the rim of the basin. It is possible also that a former outlet has been concealed beneath the recent overflows of basaltic lava near the Sea of Galilee. These are mere suggestions, however, and we know of no facts, either to prove or disprove them.

The change from the conditions of free drainage to those now prevailing seems to imply orographic movements, which cut off the Dead Sea basin from communication with the ocean and admitted of the existence of an inclosed lake.

Instead of the evaporation of a single lake in this basin, as has been assumed by certain authors, we should expect in scanning its records to find evidences of many fluctuations of water-level, and, consequently, marked changes in its fauna and flora, as well as great variation in the chemical composition of its waters. We should look especially for the records of two periods of humidity, separated by a time of extreme aridity, during which the lake waters were concentrated and deposited salt and gypsum. Following the last high-water stage, we should as a working hypothesis, postulate orographic movements which increased the depth of the basin several hundred feet, thus lowering the surface of the lake; accompanying or succeeding this movement was a climatic oscillation which caused the lake to contract owing to a decrease in humidity and an increase in precipitation.

[1] Quoted by W. H. Hudleston on the Geology of Palestine, Proc. Geologists' Assoc. vol. viii. p. 47.

[2] London, 1864, p. xii.

It has been concluded by those most familiar with the Dead Sea basin, that the ancient lakes which occupied it did not overflow. This conclusion is based on the fact that the highest terrace observed and the highest exposures of lacustrine sediments that have been noted, are several hundred feet lower than the bottom of the pass leading to the Gulf of Akabah, which seems the most probable location of an ancient outlet if one existed. It is to be remembered in this connection, however, that a special examination of the terraces in question has not been made, and from the reports published it is not evident that the highest water-record reported is the highest that exists. A critical examination of the pass mentioned above, in reference to the possible existence of a stream-cut channel across it, does not seem to have been made. If evidence of such a channel should be found, the occurrence of a wave-cut terrace at the same horizon on the borders of the basin to the north would be expected.

Among the many observations desired of the explorer in Palestine and adjacent regions, we would suggest in addition to those already mentioned, a measurement of the rate of evaporation from the surface of the Dead Sea, and the rate of evaporation of fresh water under the same general conditions. Also, a study of the succession and character of the precipitates which would be obtained on evaporating the water of the Dead Sea. The influence on the character of the salts thus obtained, of changes of temperature similar to the annual variations which occur in Palestine, should likewise be considered.

Similarity of the Dead Sea basin to the Great Basin in America.

There are so many corresponding features between the structure, recent geological history, scenery and present climatic condition of the Dead Sea basin and the Great Basin in our own country, that I am tempted to compare the two in detail. Space will not admit, however, of more than a brief summary of their points of resemblance.

The Jordan-Arabah depression is an isolated example of a type of fault basin which has been repeated many times at about the same date, in the western part of the United States, where the "basin range structure" prevails. This structure in America was impressed on a region which previously drained to the ocean, thus presenting a sequence of events which seems to have had a parallel on a smaller scale in the Dead Sea basin. The depressions which resulted from dislocation both in Asia Minor and in the Far West,[1] became the basins of large lakes during the Quaternary period. In the Great Basin some of the ancient lakes overflowed, others were not drained, and as in the case of the Dead Sea, became concentrated brines. The lakes in both instances were fresh during their greatest expansion, but became saline when concentrated. The lakes referred to in America had two high-water stages separated by a period of

[1] This convenient but indefinite term has come down to us from the time when the western part of the United States was but partially explored, and refers to the vast region west of the bold, eastern face of the Rocky Mountains. It is in this region, between the Rocky Mountains and the Sierra Nevada, that the area of interior drainage termed the Great Basin, mentioned several times in this paper, is situated.

low-water or of complete desiccation: and the same seems to be true of the ancient lake of the Dead Sea basin.

Accompanying the two great expansions of the Quaternary lakes of Utah and Nevada, was an increase of perennial snow on the neighbouring mountains and the production of glaciers, some of which were several miles in length, in the higher portions of the Sierra Nevada and Rocky Mountains. It is known from the observations of Sir Joseph Hooker, that glacial moraines occur about the base of Mount Lebanon; and it seems fair to infer that glaciers of considerable magnitude existed on the higher mountains of Asia Minor during the time that the Jordan-Arabah depression held a great freshwater sea.

At present the regions we are comparing are each arid and but thinly clothed with vegetation. Agriculture in each instance is largely dependent upon irrigation. The mountains in each country are remarkable for their brilliant colours, for the ruggedness of their sides, and for their angular outlines; in each case they are surrounded by an atmosphere of great transparency, which renders distances deceptive to those familiar with more humid regions. The desiccated lake basin known as "playas" in the Far West are represented by similar mud plains in Palestine and adjacent regions, which are dry and hard in summer and shallow lakes in winter. The dry water-courses known as arroyas in the West have their counterpart in the wadys of the East. About the bases of the steep escarpments bordering the Jordan-Arabah depression and in other similar localities, there are alluvial cones formed of debris swept out of tributary gorges and deposited as half-cones sometimes several hundred feet high, against the sides of the valleys. Similar alluvial cones of great magnitude occur again and again about the bases of the abrupt mountains of Utah, Nevada, Arizona, and neighbouring regions. The reader who has traversed the desert valleys of the Far West will no doubt be interested to learn that the familiar *Artemisia* thrives also in the Holy Land.

Many other similarities might be pointed out between the lands under comparison, especially with reference to those features which attract the artist's eye. It is to be remarked in this connection, however, that while the Far East has furnished inspiration for hundreds of painters, the Far West, with equal wealth of colour, fully as picturesque inhabitants, and far more magnificent mountain forms, still remains almost an undiscovered country.

III.—Vertebrate Palæontology in some Continental Museums.

By A. Smith Woodward, F.G.S., F.Z.S.;
of the British Museum (Natural History).

HAVING lately had the privilege of visiting several of the Continental Museums containing collections especially of Palæontological importance, some notes will perhaps be acceptable upon the present aspect of that branch of the science in which the writer is particularly interested. Such a broad survey imparts so many new ideas, and leaves so many pleasant memories of

Naturalists in the midst of their work, that it is impossible adequately to incorporate the results in any brief notice; but a few points at least seem to be of general interest.

Brussels.

To students of the Palæontology of the Vertebrata, the fine Royal Museum in Brussels has become so well known, through the researches of Dupont upon cavern-remains, of van Beneden upon Pliocene Cetacea, and of Dollo upon Wealden Reptiles, that its riches scarcely require enumeration. The work upon the huge Iguanodons is at present almost suspended; and the elucidation and arrangement of the Reptiles of the Belgian Lower Tertiaries is now in active progress. The Chelonia, especially, are receiving M. Dollo's attention, and among the latest acquisitions are remains of the large Athecan *Psephophorus rupeliensis*, from the Rupelien beds of the neighbourhood of Antwerp, of which one remarkably complete skeleton is already mounted.

Among fishes, portions of two fine skeletons of *Carcharodon heterodon*, from the Rupelian Beds of Boom, were added last year; and the Collection also comprises the large series of teeth of *Carcharodon* and other Belgian Tertiary Sharks, arranged, and in part studied, by the late Capt. Le Hon. The majority of the fish-remains from the Belgian Cretaceous and Tertiaries are very fragmentary, and a few have already been described by van Beneden and Storms; but when the Museum Collection is carefully studied and arranged, several new forms will doubtless be recognized, and further information afforded concerning some species already known, as in the case of the Selachian *Rhombodus Binkhorsti*, from the Maastricht Chalk, of which a fine small connected series of the teeth is preserved. The collection of Wealden fishes from Bernissart is still undetermined, but will shortly be studied by MM. Dollo and Raymond Storms; and this will yield several species related to, if not identical with, those from the English Purbeck.

The series of Selachian teeth from the Carboniferous Limestone of Belgium, described by the late Prof. L. G. de Koninck, is also preserved here, and will, in part, require revision in the light of more recent discoveries. *Pleurodus* is represented under the name of *Tomodus laciniatus;* and, as already noted by St. John and Worthen, *Streblodus tenerrimus* is founded upon a tooth of *Sandalodus*.

Bonn.

The Museum of the University of Bonn is contained in the palatial rooms of the old Castle of Poppelsdorf, and comprises among its Pleistocene Vertebrata the far-famed Neanderthal skull. The originals of Goldfuss' early memoirs are also here, including the well-known *Pterodactylus crassirostris* from Solenhofen—the basis of the restoration with an erroneously added fourth clawed finger, still surviving in many text-books. Some fragments of Devonian fishes from the Eifel are among the most recent additions; and Dr.

Hans Pohlig is to be met at work here, having just completed a memoir on the Pleistocene Elephants. The small Museum of the Naturhistorischer Verein is also full of interest for the stratigraphical geologist; and the fine geological repositories of Messrs. Krantz & Co., and B. Stürtz, may always be found to afford some novelties.

Berlin.[1]

In Berlin, the University Natural History Collections are at present being removed from the old building to the grand new Museums and Laboratories near the Institute of the Landesanstalt. Through the kindness of Prof. Dr. Dames, however, the writer had the opportunity of examining all the fossil fishes, and a few of the higher vertebrates, including the unique *Archæopteryx* from Solenhofen, rendered classical by the Professor's memoir. Among the earlier fossil fishes is a large series of the Lower Permian nodules from Rhenish Prussia, exhibiting remains of *Pleuracanthus* (*Xenacanthus*), *Acanthodes*, *Conchopoma*, and various Palæoniscidæ. The examples of *Pleuracanthus* and *Conchopoma* are especially interesting, several being described and figured in Kner's memoirs, and others adding much to our knowledge, at least of the former genus. The systematic position of the problematical "Dipnoan" *Conchopoma* is still very doubtful; the scales may be rhombic, as supposed by Kner, but the characters cannot be definitely determined. The fossil fishes of Solenhofen are also represented by a large collection; and the type of the Wealden *Pholidophorus splendens*, Strückmann, shows that this fish is either referable to *Semionotus*, or to the same genus as "*Lepidotus*" *minor* of the English Purbeck. An interesting series of fossil fishes from Mount Lebanon, collected by Dr. Fritz Noetling, has lately been received, and will afford several novel anatomical facts in regard to the members of this fauna, if not any new species. The Monte Bolca fish, described by Agassiz as *Diodon tenuispinus*, is also here; and a large series of Selachian and other remains from the Tertiary of Birket-el-Qurūn, Egypt, described by Dr. Dames in 1883. The Museum is fortunate in having secured the services of Dr. Ernst Koken, who entered upon his duties last spring, and the Professor, Dr. Dames, has lately extended his field of operations, having elucidated, in connection with the few specimens in Berlin, all the principal fossil Ganoids from the extra-Alpine Muschelkalk preserved in the Museums of Europe.

The Museum of the Prussian Survey and School of Mines is arranged upon the plan of the Jermyn Street Museum of Practical Geology, and does not contain many vertebrate fossils of note. Here, however, is the fine skull of a Stegocephalian from the Lower Rothliegendes of the Bavarian Palatinate described under the name of *Weissia bavarica*, by Dr. Branco, in 1886; also some of the originals of the same Professor's recent Memoir on *Lepidotus*, and a few fragments of German Devonian Fishes.

[1] Between Berlin and Munich the writer was accompanied by Mr. James W. Davis, F.G.S., of Halifax.

University Museum, Leipzig.

In the University of Leipzig, Systematic Palæontology is almost excluded by the overwhelming pursuit of Stratigraphy, Petrology, and Mineralogy; but the collection of Stegocephalia from the Saxon Rothliegendes is entirely unique, and is rendered all the more instructive by the exhaustive descriptions and enlarged figures published in Prof. Dr. Credner's well-known series of memoirs. The specimens are numbered and arranged in cabinets in the order in which they are described, as illustrating to a certain extent the life-history of each species; and accompanying all the groups are copies of the Professor's detailed drawings mounted for convenient reference. Large restored figures have also been made in the form of wall-diagrams; and the only point that appears to the present writer somewhat speculative is the arrangement of the scutes in the pelvic region, of which the evidence is not altogether clear.

Dresden.

The Geological and Palæontological Collections at Dresden, so long presided over by Prof. Dr. Geinitz, are located with the other State treasures in the old Palace of the Zwinger. With his able coadjutor, Dr. J. V. Deichmüller, the Professor still welcomes visitors to the scenes of his extended labours; and the Museum comprises a large number of vertebrate fossils of the greatest interest. Among Permian fishes, a *Pleuracanthus* from Bohemia is noteworthy for the perfection of the pelvic fins; and several teeth and a fin-spine from the Kupferschiefer elucidate some of the characters of the Cestraciont Selachian, *Wodnika*. A Kupferschiefer tooth, named *Hybodus Mackrothi*, is also interesting. A large series of Solenhofen Lithographic Stone fishes forms the basis of Prof. Dr. Vetter's important memoir, published in the "Mittheilungen" of the Museum in 1881; and an example of the rare Solenhofen Ray, *Asterodermus platypterus*, is figured in Bronn's "Lethæa." Several fragmentary fish-remains from the Saxon Chalk are described and figured in Dr. Geinitz' "Elbthalgebirge"; and a collection from the Eocene Helmstedt Phosphate Beds is made known in the Professor's papers upon those deposits. Among other vertebrates, there are also Stegocephalian fossils from the Saxon Rothliegendes, described conjointly by Drs. Geinitz and Deichmüller.

Prague.

The fame of the vertebrate fossils in the Royal Bohemian Museum at Prague has already spread afar, through the labours of the Director, Prof. Dr. Anton Fritsch. The collection is still retained in the ancient building in the Graben, the fine new Museum at the end of Wenzelsplatz being still unfinished, and probably not destined to be opened for public inspection for at least five or six years. The Vertebrate Fauna of the Bohemian Lower Permian is especially well represented, as may be inferred from Dr. Fritsch's great memoir upon the Stegocephalia and Reptilia, now completed, and as will become still more evident from the forthcoming memoirs upon the Dipnoi,

Ganoidei, and Selachii, the first of these three already prepared for issue. The pyritous character of the Gaskohle, from which many of the specimens are obtained, renders it almost impossible to ensure their permanent preservation; hence the importance of the exquisite fac-similes produced by the electro-deposition of copper, now to be seen in nearly all the principal museums, these reproductions being almost as satisfactory and reliable for examination as the originals temporarily surviving in Prague. Among the undescribed Permian fishes, the series of *Pleuracanthus* (*Xenacanthus*) is unrivalled, and Dr. Fritsch has already given naturalists a slight foretaste of the "good things to come" in a recent figure and description of the pectoral fin. One specimen shows the entire fish, in beautiful preservation, confirming in an interesting manner the recent discovery of M. Charles Brongniart in France. Bohemia also yields many Chalk fishes, and the Royal Museum contains a large series, described and undescribed. Nearly all are in a very unsatisfactory state of preservation, compared with those of England, being merely in the form of hollow moulds. They indicate a fauna very similar to that of the English Chalk, and in some cases elucidate types of which very little is known in this country; some large specimens of *Halec Sternbergii*, for example, reveal almost the entire skeleton of this ancient Clupeoid.

Among later vertebrates a large part of the skeleton of a young *Dinotherium* from Bohemia, still undescribed, is noteworthy; and there are numerous bones from the Pleistocene deposits of the country.

At the German University in Prague Prof. Dr. Gustav Laube also presides over a large palæontological collection, comprising a few of the Permian Stegocephalians described by Dr. Fritsch, and the originals of the Cretaceous *Protelops Geinitzii* and *Osmeroides levesiensis*, made known by the Professor himself in 1885.

The mission of the Palæontologist in visiting Prague is also incomplete without a brief pilgrimage up the Moldau to view the National Monument to Barrande—a simple tablet with his name, affixed to perhaps the finest section of Silurian rocks to be met with anywhere in the world. The collections of the departed pioneer in Bohemian Siluria are still packed up in the rooms he occupied, awaiting the completion of the National Museum destined to receive them.

Vienna.

From Prague to Vienna the route lies in part through the picturesque vales of Moravia, famous for their bone-caves; and the traveller leaves the quaint streets of the ancient Bohemian capital for the new promenades, parks, and palatial edifices built upon the site of the fortifications of the Imperial capital. Among the great buildings is the Hof Museum, still not arranged for public inspection, but rapidly becoming one of the finest in Europe. The best-lighted of the lofty rooms in the Geological Section is devoted to the grand Ettingshausen Collection of Fossil Plants, already in order and labelled, and each figured specimen accompanied by the published illustration. The other collections are arranged stratigraphically in the remaining

galleries, in many of the cases of which, it must be admitted, such delicate objects as fossil leaves could scarcely be seen to advantage. Not expecting to find the specimens accessible, the writer had unfortunately decided upon a very brief visit; but through the kindness of Dr. Theodor Fuchs and other members of the staff, the whole of the fossil fishes were made available for examination, and afforded some idea of the richness of the series. There is a large number of the Comen Cretaceous fishes, including the types described by Heckel; also many interesting specimens made known by Dr. Steindachner, the present Director of the Zoological Cabinet, who has unfortunately been compelled of late to desert Palæontology by the overwhelming amount of recent material absorbing his scientific energies. The Eocene Monte Bolca fishes comprise several unique specimens, among others the types of *Caranx ovalis*, *Calamostoma bolcensis*, *Solenorhynchus elegans*, *Urolophus princeps*, and *Trygonorhina de Zigni*, the last-named appearing to the present writer not to show the characters of the nasal valves requisite to separate it from *Rhinobatus*. The tail of a large Sword-fish from the Miocene of Malta is also interesting, and among earlier fishes, many noteworthy specimens occur in the collections from the Trias of Seefeld (Tyrol) and Raibl (Carinthia).

The enormous Austrian collection in the Geologisches Reichsanstalt, under the direction of Dr. Stur and Dr. Mojsisovics von Mojsvár, also comprises many vertebrate fossils of note. The remains of the Miocene "Leathery Turtle," *Psephophorus polygonus*, described by Prof. Seeley, occupies a small glass case here; and numerous fishes from the Austrian Tertiaries are being elucidated by Dr. Gorganović-Kramberger, of Agram. The greater portion of the skull of *Ceratodus* from the Rhætic will shortly be described by Dr. Teller; and among Triassic fishes the collection includes all the type-specimens from Raibl, described in Kner's well-known memoir. In the Paläontologisches Institut of the University, Prof. Dr. Neumayr has an interesting small series of Austrian fossil fishes; and in the Geologisches Institut, under Prof. Dr. Eduard Suess, are preserved the fragmentary remains of the Gosau Cretaceous Reptiles, described by Prof. Seeley.

University Museum, Munich.

Re-entering Germany, the University Palæontological Collection in Munich is the first attraction. There, in the midst of an enthusiastic group of students and naturalists engaged in original research, Prof. Dr. von Zittel adds to his numerous official duties the preparation of the great "Handbuch der Palæontologie," which has now reached the final volume. Another fasciculus will appear almost immediately, comprising the Teleostei and the Amphibia. The collection is so extensive, and contains so many type-specimens, that it is impossible during any brief visit to do more than rapidly glance over the more prominent objects. Among higher vertebrata, the series of mammals from Pikermi and the French Phosphorites is especially extensive, and has lately been turned to good account by Dr. Max Schlosser. Of reptiles and fishes, the collection from

the Bavarian Lithographic Stone is unrivalled, and comprises, among others, Wagner's *Compsognathus*, numerous Pterodactyles (including the wing described by Dr. von Zittel), several Lacertilians, many Selachians and Chimæroids, and still more Ganoids. Of great historical interest, also, is the Münster Collection—a series named and described in the early days of Palæontology, when specialists were almost unknown, and now requiring much revision. To these are added the originals of Schafhäutl's "Lethæa Bavarica," and many valuable isolated types; and the Museum is shortly to receive the huge Ichthyosaurs and other Liassic fossils from the Monastery of Banz. A nearly complete *Lariosaurus* from the Italian Trias has also lately been purchased; and important acquisitions from Solenhofen arrive continually. A week's study in a Museum of this kind leaves impressions never to be forgotten, and when added to one of the Professor's delightful Alpine excursions, such as it was the writer's privilege to join, the memory becomes particularly pleasurable.

STUTTGART.

The State Museum in the ancient capital of Würtemberg is another well-known centre of interest for those concerned with the Palæontology of the Vertebrata. Foremost in their unique character, perhaps, are the Reptiles and Amphibia, with a few Fishes, from the Würtemberg Keuper and Lettenkohle. Unfortunately, however, the reptiliferous beds have rarely yielded anything of note during recent years. Besides the remains of the Crocodilian *Belodon*, and the Dinosaurian *Zanclodon*, there is Dr. Kapff's large group of *Aetosaurus ferratus*, forming the subject of the memoir in 1877 by the present Director, Prof. Dr. Oscar Fraas. It is a marvellous fossil, of which no figure and description can give any adequate idea. The huge Stegocephalians from the same beds are also prominent, and will shortly be described in a memoir in course of preparation by Dr. Eberhard Fraas. The few fishes belong mostly to *Semionotus*; and it is almost certain that the supposed portion of the jaw of a Pterodactyle, described by H. von Meyer, pertains to a fish like *Belonorhynchus*. The Würtemberg Lias is represented by several Ichthyosaurs—including the specimen with three fœtal individuals, described by Prof. Seeley, and a recently-acquired paddle showing the integument, described by Dr. E. Fraas. There are also many Liassic fishes, and among these are some specimens labelled *Semionotus leptocephalus* in Agassiz' handwriting, showing that this species truly pertains to *Pholidophorus*, as already suspected by Dr. Oscar Fraas. A small example of *Palæospinax* is a novelty. Other fine fish-remains are exhibited from the Würtemberg Lithographic Stone of Nusplingen, including the so-called *Squatina acanthoderma*, which is probably identical with *S.* (*Thaumas*) *alifera*; and the collection of the distinguished author of the "Aus dem Orient" naturally contains many treasures from Mount Lebanon. Among Mammals there are two teeth of *Microlestes* from the Upper Keuper Bone-bed of Bebenhausen, Würtemberg; and Prof. Fraas also shows the originals of his classic work upon the Steinheim Fauna, besides many unique

examples of the Bohnerz mammalia, and Pleistocene bones too numerous to mention.

University Museum, Tübingen.

Amid the low rounded hills and broad fertile valleys of Swabian Würtemberg, lies the small city of Tübingen, the home of Professor Dr. Quenstedt. There, in a lofty old building upon the slopes overlooking the Neckar, it is a privilege and pleasure still to be able to meet the venerable Professor surrounded by the fossils illustrated in his works and memoirs extending over a period of not less than 53 years. The collection is almost exclusively local, and among Vertebrata contains many unique and typical specimens of great interest. From the Trias there are fine remains of *Zanclodon*, including a foot; also the natural mould of a Chelonian, lately added, perhaps identical with *Chelytherium obscurum*, H. von Meyer. From the Lias several well-preserved Teleosaurs and Ichthyosaurs are exhibited, some of the latter containing fœtal young; also an unrivalled series of examples of *Lepidotus elvensis*, described in the Professor's memoir, 40 years ago; and the dentition of a Cestraciont Selachian, closely allied to *Strophodus*, more recently made known under the name of *Bdellodus bollensis*. The Lithographic Stone fossils include the type of *Pterodactylus suevicus*, an example of *Rhacheosaurus*, the original group of teeth of *Notidanus serratus*, and many remains of Chimæroid and Ganoid fishes. Among Mammalia several fine series of teeth from the Bohnerz are exhibited, a few remains from Steinheim, and a few from the Würtemberg Pleistocene deposits.

Darmstadt.

When on the confines of Hessen-Darmstadt, the palæontologist is naturally attracted by the works of Kaup and Lepsius to the State Museum in Darmstadt. At present the collections are arranged in some of the rooms of the old Castle in the middle of the city, but, as almost everywhere, the demand for a specially constructed building is raised, and it is expected that before long the want will be supplied. Here, as might be supposed, the Tertiaries of the Mayence Basin are especially represented; and one of the most pleasing features of the collection consists in the large number of entirely new Mammalian fossils from Eppelsheim continually being acquired through the well-directed energies of the present keeper, Prof. Dr. Lepsius. Species known in the days of Kaup from little more than detached teeth are now represented by fine jaws and limb-bones; and the original type series begins to appear very small and insignificant. The collection of remains of *Halitherium* from Alzey and Flonhein is probably unique; and for this series, too, recent acquisitions await extrication from matrix in the cabinets of the Professor's study. The original remains of the remarkable Camel-like genus and species, *Merycotherium sibiricum*, from the Pleistocene of Siberia, are also here; and among reptiles may be noted the series of Mayence Crocodilian remains described by Ludwig in 1877. To the latter has lately been added the elongated snout of a large indi-

vidual, very suggestive of the genus *Rhamphosuchus* from the Siwalik Beds of India. Several undescribed fishes from the Mayence Basin are also represented; and among the latest additions is a portion of the trunk of a large rhombic-scaled ganoid, like *Lepidosteus*, from the Brown-coal of the neighbouring village of Messel.

University Museum, Strassburg.

Passing south to the University of Strassburg, we find the Professor of Geology and Palæontology also contemplating removal to more commodious quarters. The building of the new Geologisches Institut is yet only half erected, near to the great University Institutes devoted to Botany, Physics, and Chemistry. The palæontological collection under the care of Prof. Dr. Benecke is very extensive, and contains a few vertebrate fossils of note. The counterpart of the paddle of the Würtemberg *Ichthyosaurus*, already noticed at Stuttgart, is preserved here—a somewhat unfortunate separation of the halves of so unique a specimen. One moiety of the Jordan Collection of Lebach Permian fishes is also to be seen, the other moiety being in Berlin; and the types of Kner's *Conchopoma gadiforme* are thus separated, two of the series (the originals of pl. i. fig. 1, and pl. iii. of Kner's memoir) being preserved in Strassburg. Other specimens are two of the original teeth of the common *Otodus obliquus* from Sheppey, figured by Agassiz, and some of the types of *Carcharodon productus*, *C. leptodon*, and *C. megalodon*; also some Selachian teeth, figured by Gervais, from the Muschelkalk of Lunéville. The Director of the Natural History Museum, Dr. Döderlein, is at present engaged upon the study of a fine series of the Lebach *Pleuracanthus* (*Xenacanthus*); and the Assistant in Palæontology, Dr. Otto Jäkel, is in the midst of researches upon the microscopical structure of Selachian teeth, particularly those of the Alsatian and Silesian Muschelkalk.

Paris.

The great Museum of Natural History in Paris is too well known to require more than a passing notice. Prof. Gaudry's collections of fossil Mammalia from Pikermi and Mont Lebéron, a large series of Mammalia from the French Phosphorites, and Cuvier's Gypsum Mammalia, are to be seen; also the Gazzola collection of Monte Bolca Fishes, and some fish-remains from Mount Lebanon, collected by Prof. Gaudry. Conspicuous among recent additions are specimens of the Stegocephalian *Actinodon*, and some other vertebrates from the Middle Permian of Autun, lately described by the Professor. The public are also now well provided for in the new temporary Gallery of Palæontology, in which are exhibited the great skeleton of *Elephas meridionalis*, from Durfort (Gard), a reconstructed skeleton of *Mastodon angustidens*, from the Miocene of Simorre (Gers), and mounted skeletons of *Megatherium*, *Scelidotherium*, and *Glyptodon*, *Cervus hibernicus* and *Ursus spelæus*, besides a slab of gypsum with a nearly complete skeleton of *Palæotherium magnum*. With these are placed four examples of *Dinornis*, and several well-known reptilian fossils, in addition to a few of the larger Monte Bolca fishes.

BOULOGNE.

The Museum of Boulogne is presided over by Dr. H. E. Sauvage, the Director of the Station Aquicole, and is especially rich in historical antiquities, mainly discovered in the immediate neighbourhood. A typical collection, however, represents local geology and palæontology, and the vertebrate fossils have been described in some of the well-known works of the Director. A Portlandian *Rhinobatus (Spathobatis)* seems to be scarcely distinguishable from the great *Rhinobatus mirabilis* of the Solenhofen Lithographic Stone; and the Kimmeridgian fossils are very like those of England.

In concluding these brief notes, the writer would once more express his warmest thanks to all whose cordial receptions everywhere added to the enjoyment of the tour. In the Scientific World there is certainly no nationality; and a practical interest in any particular branch of study is an amply sufficient passport to all scenes of scientific activity, wherever they may be.

IV.—The Volcanoes of Barren Island and Narcondam in the Bay of Bengal.

By Prof. V. Ball, M.A., F.R.S., F.G.S.,
Director of the Science and Art Museum, Dublin.

Second Notice.

ABOUT nine years ago I contributed to the pages of this Magazine,[1] an account of the two above-named volcanoes, which was founded on observations made during brief visits by myself in the year 1873, and on the published records of visits by previous observers. My present object is to draw attention to information which has since then been acquired regarding them.

BARREN ISLAND, Lat. 12° 15′, Long. 93° 50′.

As Barren Island affords a typical example of a volcano having an encircling outer crater with an inner cone, it has attracted the notice of many authors who have written either on general geology or on special volcanic phenomena, and it has often been described by them; but, as I pointed out, their descriptions have, unfortunately, interwoven with the facts a certain amount of myth, the origin of which I was, however, enabled to indicate. It was due to the misconception by Von Buch of the meaning of the English description by Blair, from which he quoted, that he gave currency to the statement that the sea had access to the interior of the old crater and surrounded the inner cone. For this statement there is not a shadow of historical evidence, the records so far as they go prove the contrary. At the same time it very possibly may have been the case at a prehistoric period in the life of the volcano.

In the year 1884, what may be described as the first exhaustive geological and topographical survey of these two volcanic islands was made by Mr. F. R. Mallet and Captain Hobday, who spent nine

[1] GEOLOGICAL MAGAZINE, Vol. VI. 1879, pp. 16-27.

days at Barren Island and four at Narcondam. The results have been published by Mr. Mallet,[1] and his paper gives a most interesting account of both islands, which is accompanied by several valuable maps and sections, all of which may be said to supersede what has been previously published.

In referring to the subject again, I desire to point out, in the first place, that I quite agree with Mr. Mallet that the crater at the summit of the cone on Barren Island as he saw it in 1884 was practically in the same condition as when I saw it in 1873, and that consequently there has been no active eruption during the interval of eleven years.

Unfortunately I cannot now definitely account for the fact that there is a difference in the bearings of the larger sides of the crater, as given by Dr. Playfair and myself, from those ascertained by the recent survey. It is possible that I may have quoted Dr. Playfair's bearings either by mistake or because my own memorandum had been lost. Be that as it may, the elliptical hollow as now described and represented corresponds in all its details with my recollection of what it was when I saw it.

We may indeed, I think, with perfect safety, push back the period of the quiescence of the volcano still further. There is before me an original copy of a photograph taken by M. Mellitte for Dr. Mouat, whose signature it bears and the date, Dec. 1857. It represents the cone with its characteristic points exactly as it is shown in the lithograph from a photograph which is given in Mr. Mallet's memoir. During this period of 27 years, that is to say, up to 1884, the only observed manifestation of internal action has been afforded by the outpouring of steam and sulphurous vapour from a portion of the edge of the crater.

In the *Bombay Times*, during July, 1852, the volcano is said to have been described "as very active." I was unable, when in India, to verify this statement by reference to the original. Possibly the paragraph itself might show whether this was only an exaggerated way of describing the issue of steam from the summit. If the volcano was really in a violent state of eruption in that year, there should be, one would suppose, abundant record of it in the logs of passing vessels.

Nothing can be more conclusive as to the cooling down of the lower parts of the lava which occupies the valley between the old outer crater and the cone, and perhaps it may be added the exhaustion generally of the energy of this volcano, than the records of the temperatures of the hot spring as observed during the period from 1832 to 1884. In 1832 it was described as almost boiling; in 1857 (Drs. Mouat and Playfair) it was too hot to be borne by the hand, their thermometer was only capable of measuring up to 140° F.; in 1858 (Dr. Liebig) almost boiling; in 1862 (Rev. C. Parish) scalding hot; in 1866 (Andaman Committee) 158°—163°; in 1873 (V. Ball) 130°; in 1884 (F. R. Mallet) 106°—116°. These observations are not sufficient to establish the rate of cooling, though

[1] Mem. Geol. Survey of India, vol. xxi. pt. 4.

the later ones indicate that the rate itself has diminished as the cooling has progressed, in general accordance with the well-known law.

It is proved by the historical records quoted in my paper, and also in Mr. Mallet's, that the volcano was in a state of violent eruption in 1789 (Blair) and 1803 (Horsburgh), and that columns of smoke, or rather as it should be, steam, were observed rising from it in 1787 (Colebrooke) and 1791 (Horsburgh).[1] I have now to add a hitherto unnoticed record of its appearance on the 29th January, 1804, as seen by an officer of His Majesty's ship "Caroline," who writes: "On the same evening we got sight of Barren or Volcano Island, which at the time was burning very fiercely, the eruptions taking place every eight or ten minutes, with a hollow rumbling noise.

"This is a small circular island lying almost in sight of the East Andaman, between that and the Malay coast; it appears to be a perfect cinder, or at least covered in every part with lava; it is of considerable height, and the volcanic opening or crater is in the centre of the island.

"We passed within a mile of it, and as the winds were trifling we observed the eruptions for three days and nights successively."[2]

As we have no records of the condition of the volcano between 1804 and 1832, we cannot fix an exact or even approximate date for the more recent lava flows, nor can we fix the total duration of the violent stage, which, probably, with quiescent intermissions, lasted for at least 15 years, namely, from 1789 to 1804.

Blair does not refer to the lava flows, from which it has been concluded that they did not exist when he visited the island, but this negative evidence is perhaps hardly sufficient for a definite conclusion. Indeed, the break in the side through which one of the flows reaches the sea has very much the appearance of having been formed by the flow itself, as in the case of Campo Bianco in the island of Lipari (Volcanoes, by Professor Judd, p. 125). If such was the case, as the breach existed in Blair's time, the lava flow must also have been in existence then. Mr. Mallet has some remarks upon the order of sequence of the three flows, which probably exhaust the possible conjectures in regard to them. The earliest mention of them is by a visitor who landed in 1832, and they are referred to by Captain Miller in 1843.

Since my paper was published a sketch of the Island by an officer of the Kwang-tung steamer, with a brief descriptive account, was published in the "Graphic" for April 16, 1881; but as the drawing gives an incorrect representation of the form of the cone, and the

[1] There is a very circumstantial account of a violent volcanic eruption in the Bay of Bengal, by which an island a league in length is said to have been formed in the sea three leagues from Pondicherry, in the year 1757. As in the case of Graham's Island, in the Mediterranean, the Island subsequently disappeared, having been eroded by the sea. The original is to be found in the *Annual Register*, vol. i. 1758. It is quoted in the *Journal of the Asiatic Society of Bengal*, 1847, vol. xvi. p. 499.

[2] Account of a Voyage to India and China, etc., in His Majesty's Ship Caroline, performed in the years 1803-4-5, interspersed with Descriptive Sketches and Cursory Remarks by an Officer of the Caroline. See Phillips' Voyages and Travels, vol. v.

letterpress appears to be founded on previous accounts, it is not of much value.

The more important dimensions of this Island which have now been definitely ascertained are as follows:

Maximum diameter of Island	about 2 miles.
Circumference	,, 6½ ,,
Height of outer Crater...	1100 feet.
Estimated height of original Cone	3300 ,,
Height of inner Cone	1000 ,,
Angle of slope of Cone...	32°

Narcondam, Lat. 13° 26′; Long. 94° 15′.

The account by Mr. Mallet of this volcano is, in some respects, of greater value, though less interesting than that of Barren Island. This is due to the fact that it had never been so thoroughly examined as the latter has, and because the total information regarding it was vague and incomplete.

We now know that its highest peak rises to 2330 feet above the sea, that it retains no remnant of any crater, and owing to the absence of clearly marked alternations of lava and ash, such as occur in Barren Island, there is some probability that it never had one. In other words that it may, as Mr. Mallet suggests, owe its origin to the "extrusion of viscid lava without the accompaniment of crater-forming materials," like the domite Puys of Auvergne.

The lavas of Narcondam, unlike those of Barren Island, are of a very uniform character; felspars, both triclinic and orthoclinic, occur in them, causing them to be of a very pale colour, and they include both hornblende and augite—the latter in a subordinate degree; they are in short, according to Mr. Mallet, hornblendic andesites, and are distinctly more acidic than are those of Barren Island.

Certain agglomerates consisting of rounded and angular fragments of lava embedded in a finer matrix are largely developed on the coast. They appear to have been formed by pluvial action, as no trace of marine organisms has been observed in them.

My observations on Narcondam having been limited to the neighbourhood of one small bay, I could only speak as to the absence of any evidence there of recent volcanic action. Mr. Mallet has, however, confirmed this for the whole island, and there is no record, so far as is known, of the volcano ever having been observed in a state of activity.

Colonel Yule[1] has, however, suggested a Sanskrit derivation for the name, *Naraka-Kondam* = "a pit of hell," as being possibly connected with a period when the volcano was active; but Mr. Mallet has collected evidence from old charts which tends to prove that there was confusion between the two islands, and that the name Narcondam may have been at one time applied to Barren Island—to the form of which the title "a pit of hell" would not be inappropriate, and with the probability of this being the true explanation Colonel Yule[2] has expressed his concurrence.

[1] Marco Polo, bk. iii. ch. 13, note.
[2] Anglo-Indian Glossary, art. Narcondam.

The conical shape and abrupt appearance of the island, in the middle of the sea, were probably sufficient to cause it to be regarded as a volcano by voyagers, as none of them refer to having witnessed any of the ordinary volcanic phenomena, and but very few ever actually landed on the island.

As all recorded dates of the periods when these islands were seen by travellers are of considerable interest, the following should be added to those given in my previous paper. According to Col. Yule Narcondam is first referred to by Linschoten in the year 1598 under the name of *Viacondam*. In Surgeon Finlayson's account of Crawfurd's mission to Siam we find the following under the date Dec. 3, 1821:—"On the following morning, at sun-rise, we were within sight of Narcondam, an island apparently several miles in diameter, in form and shape a perfect specimen of the volcanic cone, which we calculated to be about two thousand five hundred feet above the sea. We were at too great a distance to entertain a hope of landing on it. This island from its height, its solitary existence in a wide sea, and its singular and beautiful form constitutes a very striking object."

Dimensions of Narcondam.

Maximum diameter of Island	2½ miles.
Circumference	6½ ,,
Height	2330 feet.

V.—Sections of Bagshot Beds at Finchampstead, Berks.

By the Rev. A. Irving, D.Sc. (Lond.), B.A., F.G.S.

CONSIDERING the interest that has been awakened of late in the Bagshot Beds of the London Basin, and the paucity of good sections open to the light of day exhibiting any considerable vertical range of those beds, it has occurred to me that a fuller description of these Finchampstead sections may be of sufficient interest to students of Tertiary geology to justify its appearance in the pages of the Geological Magazine.[1] In the task we have before us of attempting to work out the old physical geography of the Lower Thames Basin in later Eocene times, every *contribution of facts* (by no means the easiest part of inductive science) must be welcome to students of the subject. The problem was sketched in its outlines and bequeathed to his successors by the versatile mind of the late Prof. John Phillips, F.R.S. "In considering these remarkable strata (he says,[2] of the London Bagshot Beds), which were accumulated in a period so near, geologically speaking, to our own, we are presented with problems of great interest, which, if they can be solved, will have more than local application. Whence came the materials, the clay, the sand, the pebbles? In what direction, by what forces

[1] The Editor much regrets the delay which has arisen in the publication of this paper.

[2] "Geology of Oxford and the Valley of the Thames," p. 450. There is a slight error on the same page: "the highest land which [the Bagshot beds] reach in this area" is the plateau of Cæsar's Camp and Beacon Hill south of Aldershot, not Hampstead Heath. He is, I believe, also in error in ascribing the 'flint-pebbles' to river-action so far as the rounding of them is concerned.

urged? What were the tracts of sea and land, how deep the water, how high the land? What is the explanation of the appearance of fluviatile shells among oceanic exuviæ?" The subject as thus sketched is, it will be admitted, one of far wider and more general interest than such minor questions (which crop up in connexion with it) as can be settled by the ordinary rules of stratigraphy. It is easy to indulge in premature speculation on the subject; but sound inductive science requires the slow and patient antecedent process of accurate observation, and a record and comparison of facts. While feeling our way to such ultimate conclusions as may be established, not on an aggregation of opinions or 'views,' but as rigid inductions from facts, many minor inductions must of course be made and criticized, some of which will have to be abandoned in the light of fuller knowledge. It is therefore desirable that, when exceptional facilities occur (such as were presented to Prof. Prestwich some 40 years ago at Goldsworthy), a careful record of the facts should be preserved.

The present paper will be mainly occupied with the detailed description of some sections at Finchampstead, Berks, in which the whole complexus or group of the Middle Bagshot Beds is exposed. One or two of these sections have been referred to on previous occasions by myself[1] and by other writers,[2] and in one instance a sectional drawing has been given.[3] Convinced, however, that that was not exactly in accordance with the facts, the author (Oct. 1886) got some rather extensive excavations made in the old clay-pit on the north side of Wick Hill near Ninemile Ride, and the section thus obtained, when correlated with the open section in the California brickyards on the other side of the road, the levels being taken from one spot to the other (a distance of 330 yards), was found to furnish the details given in the figured section of this paper (p. 411).

In these combined sections in the Wick Hill clay-pit, and in the California brickyard,[4] the Middle Bagshot beds are seen to attain a thickness of about 50 feet as compared with quite 70 feet in the well at Wellington College. This diminution is entirely at the expense of the green-earth series (Nos. 7 and 8 of the latter section). This, as I have shown in recent papers read before the Geological Society, is found to be the case generally, the 41 feet of the well-section dwindling down to 20 feet in a distance three-quarters of a mile to the north, the attenuation of those beds being complete before we reach Easthampstead. In this section they may be represented by only 16 feet, while the upper clay-bed (9 feet thick at Wellington College, and 6 feet thick in the Station cutting) is here seen developed to 10 feet, the boundary-line between it and the bed next below being drawn where patches of green earthy sand first appear. This is not the only case in which this bed is found to assume a greater thickness as we approach the London Clay; at

[1] Q.J.G.S. vol. xli. p. 504. Wick Hill is named on some maps 'Upwick's Hill.'
[2] Q.J.G.S. vol. xlii. p. 408.
[3] *loc. cit.* fig. 2, p. 409.
[4] Sections P and Q of my last paper (Q.J.G.S. vol. xliv. p. 172).

Swinley (*e.g.*), where its horizon is determined by its relation to the Upper Bagshot Sands of Tower Hill, and to the dark green sand which is found everywhere beneath it in the trial holes which have been made in Mr. Lawrence's brickyards, it attains a thickness of 12 to 14 feet.[1] The increased argillaceous character of the green-earth beds in the Wick Hill section, to such an extent as to almost obliterate their green earthy character, by the development of strong clays, is definitely anticipated in the intermediate country in the direction of Wellington College.

Thus a strong unctuous grey clay is found in thin beds intercalated with the green earths on the north side of Wellington College estate; and in what is known as Holloway's Land on the north side of the Duke's Ride, the clays of the green-earth series are so considerably developed, that a few years ago they were worked for bricks. They are partly grey, partly purplish clays, with numerous included patches and small layers of the typical green earthy sands. The upper clay-bed in the Wick Hill section has more green earthy sand in proportion to the clay-seams than it has in the cutting north of the station; but both the green sand and the clay-seams are of the same quality, and the physical character of the bed is the same in both sections. More extended observation of the Bagshots has led me to regard the upper 5 feet or so of coarse loose sand, with a few strongly-marked clay-seams in the California sub-section, as not a true Bagshot Bed at all. It is much less compacted than they are; it has a strong pseudo-dip to the north, as is seen again in the excavation by the rifle-butts; and in one pit-face I measured lately a dip of $2\frac{1}{2}^{\circ}$ W.N.W. It is, I believe, nothing more than a deposit formed by the run of the hill to the south in post-Bagshot times.[2] The section-diagram and the marginal descriptions of the several beds are made from measurements and notes taken on the afternoon of the day on which the clean excavation was made for me in 1886, and from the open clay-pits in the brickyard. The lower part of the California sub-section is constructed from data furnished in two wells at the engine-house.

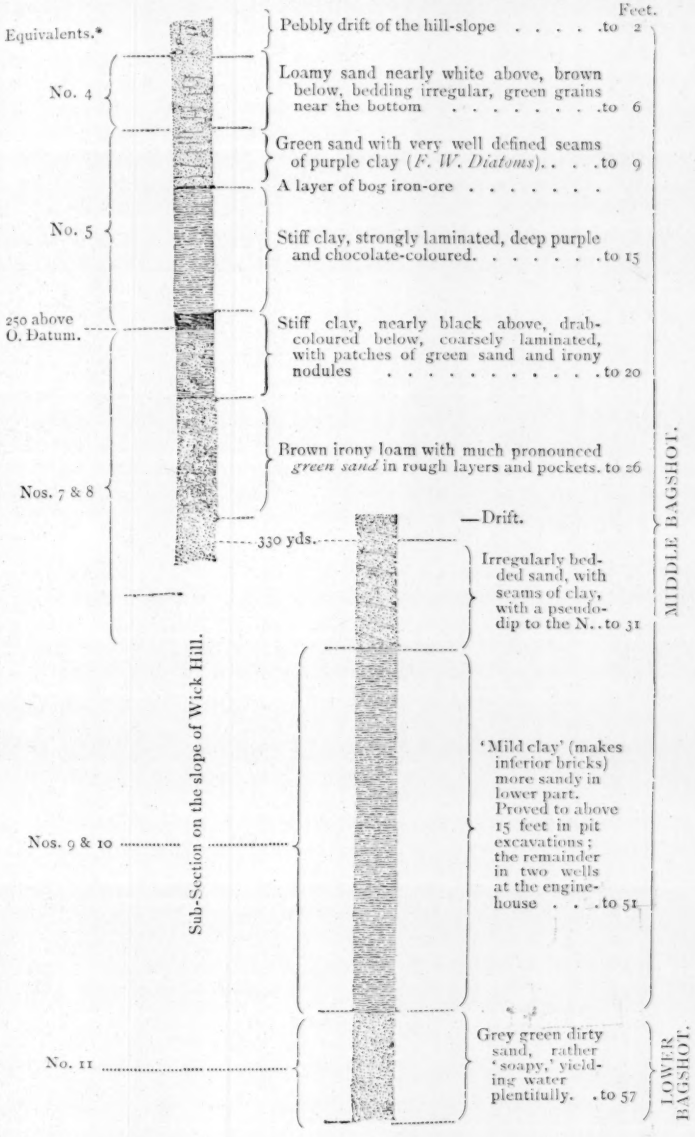
There being good vertical sections at right angles of the lower clay-and-laminated-sand-bed in the open pits in the brickfield, the absence of any measurable dip in it may be predicated with some degree of certainty. Yet a considerable dip would be required in order to bring them into the Lower Bagshot, if we take into account the position of the green earth series (20 feet exposed) with the clay-bed above it at Heath Pool, the position of the Upper Bagshot

[1] For fuller details see Section L of my paper on "The Stratigraphy of the Bagshot Beds of the London Basin," Q.J.G.S. May, 1888.

[2] A similar 'run of the hill,' with a pseudo-dip 'rather north of east' on the side of Thorn Hill, Aldershot, has been wrongly noted as a dip of the Bagshot beds there (Q.J.G.S. vol. xlii. p. 410). Here, however, the character of the deposit is more suggestive of rearrangement in a shallow lake; possibly on the margin of the Thames-valley arm of the great extra-morainic lake of the late Prof. H. Carvill Lewis, whose loss we deplore. To add anything to the sketch of his character at the end of the article in "Nature" (August 9th, 1888) would be an attempt to 'gild refined gold.'

SECTION OF MIDDLE BAGSHOT BEDS,

SHOWING DETAILS OBTAINED DURING EXCAVATIONS ON THE NORTH SIDE OF WICK HILL, FINCHAMPSTEAD, AND IN CALIFORNIA BRICK-YARD.


Feet.
Equivalents.*
Pebbly drift of the hill-slope . . . . .to 2
No. 4
Loamy sand nearly white above, brown below, bedding irregular, green grains near the bottom . . . . . .to 6
Green sand with very well defined seams of purple clay (F. W. Diatoms). . . . .to 9
A layer of bog iron-ore . . . . . .
No. 5
Stiff clay, strongly laminated, deep purple and chocolate-coloured. . . . . .to 15
250 above O. Datum.
Stiff clay, nearly black above, drab-coloured below, coarsely laminated, with patches of green sand and irony nodules . . . . . .to 20
Brown irony loam with much pronounced green sand in rough layers and pockets. to 26
Nos. 7 & 8
—Drift.
330 yds.
Irregularly bedded sand, with seams of clay, with a pseudo-dip to the N. .to 31
MIDDLE BAGSHOT.
Sub-Section on the slope of Wick Hill.
'Mild clay' (makes inferior bricks) more sandy in lower part. Proved to above 15 feet in pit excavations; the remainder in two wells at the engine-house . . . .to 51
Nos. 9 & 10
No. 11
Grey green dirty sand, rather 'soapy,' yielding water plentifully. .to 57
LOWER BAGSHOT.
Sub-section in bk. yd.

* (Nos. as in Section fig. 1, Q.J.G.S. vol. xli. p. 404.) The bracketing on the left-hand side of the figure must be regarded as tentative. In Q.J.G.S. (vol. xliv. p. 172) reasons are given for assigning the stiff, chocolate-coloured clays to bed No. 7.

Sands in the lane a little way to the south below Ridge Farm, and the position of the whole Middle Bagshot group, on the other side of Ninemile Ride (Q.J.G.S. vol. xliv. pp. 171, 172). These facts so strongly substantiate the mapping of these California beds as the *basement-beds of the Middle Bagshot*, that their true horizon can scarcely be a matter for further discussion.[1] The 20 feet of clays and loams, with included irony nodules, which are here recognized as constituting the basement-beds of the Middle Bagshot, seem to mark the most persistent and constant horizon through the whole Bagshot district; they are as distinctly recognizable at their southern outcrop at Aldershot, Ash and Woking, as they are on this northern side.[2] In every case where they do not overlap the Lower Bagshot, and rest directly upon the London Clay, they are succeeded downwards by a fine quartz sand, generally containing minute flakes of glassy silica. In most of the well-sections known to me on the northern side of the district, this is a dirty carbonaceous sand, generally blackish with a tinge more or less of green, and it usually contains lignite and pyritous material, the latter often cementing the sand into hard nodules. On the other hand, where it crops out at the surface, it occurs as a much cleaner sand (in places almost a 'silver sand'), from long exposure to the oxydizing action of atmospheric waters. This succession, which is seen in the wells at California (see section), is seen in the banks of King's Mere, and near the railway about three-quarters of a mile to the east; it occurs again in the valley three-quarters of a mile north of Wellington College, where I have lately proved the base of these loam and clay beds of the Middle Group by excavation; at exactly the same altitude (215 O.D.); it is seen at Wokingham, in the railway-cuttings at Buckhurst and Bracknell, in the Pinewood Brickyard by the Ninemile Ride ($1\frac{1}{2}$ miles east of California); it was proved in a well at Longmoor, about a mile to the west, some years ago, and in a well at the village school, Finchampstead, which was dug two years ago. At the western end of Finchampstead Ridges we can trace the succession of the beds by a number of road-sections, from a section in the Upper Bagshot at North Court (300 O.D.)[3] down through the pebble-bed (at about

[1] Q.J.G.S. vol. xli. p. 504; also *ibid.* vol. xlii. p. 408. There is, moreover, nothing in the known structure of the Lower Bagshot Beds of the deep-well sections of this northern side of the district to warrant the assignment of those beds to that group.

[2] I have traced and mapped for the most part their outcrop along the northern flank of the Bagshot area from Farley Hill south of Reading to Englefield Green (see last paper, Q.J.G.S. May, 1888).

[3] Recently a new road-cutting 8 to 10 feet deep, close by North Court, has given us a capital section of the Upper Bagshot Beds. The beds are of the usual character in the lower part of the section, but these pass upwards by a steady gradation into a very stiff irony 'leathery' loam, in which occur numerous pipes and small layers of loose sand intermingled with many black and some green grains. They are infillings in all probability of the holes and tubes left by the decay of the roots and rhizomes of plants that grew *in situ*, when, after the close of the Bagshot period, the ancient marine estuary became reconverted by an ordinary silting-up process into land. Emptied of the contained sand, these holes and tubes bear a striking resemblance to those often seen in Sarsen stones (cf. remarks by the author, Proc. Geol. Assoc. vol. viii. p. 155).

260), the upper clay, the green earths (at East Court) and the lower clays and sands of the Middle Bagshot basement-bed, which is seen in small road-sections cropping out below the green earths (the junction being exposed in section continuously for about 20 yards), till we come to about 210 (O.D.) at the village school. Here the well just mentioned gives the following sections:

a.	Yellow stiff ferruginous clayey (laminated) sand	10 feet
b.	Greenish-black sand with pyritous nodules	5 ,,
c.	Running bluish quartz sand with lumps of stiff black clay	5 ,,
		20 feet

The succession of the whole Middle Bagshot series immediately above leaves no room for doubt as to the horizon here. At Longmoor (the particulars of this well were given me by the man who dug it) the section is as follows:—

a.	Gravelly drift	1 foot
b.	Soft loamy yellowish clay, "like that now dug in the California pits, but not quite so strong."	3 feet
c.	Soft loose sand	12 ,,
		16 feet

This is near the outcrop of the London Clay.

In my last paper (Q. J. G. S. May, 1888) particulars are given of the structure of the Church Hill which forms the westernmost spur of Finchampstead Ridges, and of the stratigraphical relation of the beds in the Bearwood Hills to those in that hill, from which I still maintain that the recognition of the pebble-bed horizon in the Barkham pit, and in Coombe Wood, as marking the base of the Upper Bagshot, fits in well with the structure of the adjoining country. This could easily be shown in a section drawn about north-west from Wellington College, so as to include the well-section there, the section at the station, and that of a well dug lately (1886) behind the Wellington Hotel, the section in the pinewoods near Heath Pool,[1] and the Wick-Hill-California section.

The facts described in this paper, and in those which have recently appeared in the Geol. Society's Journal, admit of one simple explanation, and that is a gradual (though not uniform) attenuation of the Lower Group of quartz sands (ninety-five feet thick at Wellington College) and of the green-earth beds of the Middle Group. In consequence of this, the gradients of the basement clayey beds of the Middle Group, the base of the Upper Group, and the surface of the London Clay, form a triad of horizons which approximate nearer and nearer to one another as we trace them to the north; and, as a further consequence of this, beds of higher horizons overlap in places those of lower, and rest upon an eroded surface of the London Clay along the line of country by Bearwood, Wokingham, Buckhurst and Bracknell, so that we have pretty clear indications of the northern shore-limit of the ancient Eocene estuary, traces of its affluents being recognized at Ascot and Wokingham.

Supplementary Note.—In a former paper (GEOL. MAG. Dec. III.

[1] Section O (Q.J.G.S. vol. xliv. p. 171).

Vol. II. p. 18) the author spoke of the well at Finchampstead Rectory as penetrating the Upper Bagshot Sands, mainly on account of the absence of green earthy sands in the section. In the face of the facts since brought to light in connexion with the stratigraphy of Finchampstead Ridges, this view is seen to be untenable. The absence of any noticeable quantity of green earthy sands in the well is probably accounted for by such a lateral variation of the lithological character of the Middle Bagshot beds as has been noticed in this paper at Wick Hill; and when this is taken into account, it will be seen that the relegation of the beds in the hill on which the Rectory stands to the *Middle* Bagshot does not affect materially the argument of the previous paper, which dealt merely with the question of Water Supply. It is the basement-bed of the Middle Group which forms the water-bearing horizon in the hill on which the Rectory stands, and the surrounding country is chiefly indebted to the clayey beds of this group for its fertility and the charms of the landscape.

VI.—On Some Rock Specimens from Somali Land.

By Miss C. A. Raisin, B.Sc.

As not much appears to be known about the geology of Somali Land, a description of some specimens, forwarded by Col. M. Gosset, and collected by Capt. King, the Political Officer at Zaila, may be of interest. These specimens were sent to Prof. Rupert Jones, who requested Professor Bonney to undertake the description of them. As, owing to unexpected pressure of work, he found it difficult to spare time for this purpose, he placed them in my hands, and the work has been done at University College under his superintendence.

The collection of rocks was made during an expedition from Zaila to Mount Eilo. Zaila is on the northern coast of the Somali Land, and Mount Eilo lies to the south-east, on the northern frontier of the Gadabursi country. The account, sent by Capt. King, gives us the following particulars of the district. The hills consist mainly of limestones, which are usually crystalline, and somewhat fissile. One variety is a fine-grained, hard, lithographic stone, which is grey, yellowish-grey, or reddish-brown in colour, and breaks with a marked conchoidal fracture. Boulders of this stone occur abundantly in the river-beds, and some of the slabs appeared as if they had been artificially quarried for lithographic purposes. A sandstone generally of a reddish-yellow colour is associated with the limestones. It is hard, fine-grained, and massive, and is well adapted for grindstones. The hills exhibit a clearly marked stratification, and the beds dip usually at an angle of from 20° to 25°.

Felspar and hornblende-bearing rocks [a porphyrite and a hornblende-diabase], and one which is greenish and compact [an epidosite], occur near the foot of the hills, while outcrops of mica-schist and gneiss are exposed in the valleys, where we find also abundance of fragmental quartz.

Over sheltered valleys, such as the Koton, there is spread a thick covering of rich soil. The main valleys are long, and have a gentle slope; and in these, large boulders rarely occur, but they are common in the short and steep ramifications, and the exposed slopes of the hills show signs of very extensive denudation. The detritus, thence derived, has been carried down, until its transport was checked by the sea and by the fringe of coral reefs, and the deposit then accumulated backwards, building up the immense alluvial plain in the form of a long, narrow, and scarcely perceptible basin, parallel to the coast-line. The light, argillaceous portion of the detritus reached the coast first. It was there rapidly deposited and formed an impermeable stratum, which retains both the local rain water and that which is absorbed further inland. As a result, abundance of water is obtainable all along the coast, from the Gulf of Tajurra to Bulhar, within three or four feet of the surface, while in the alluvial plain further inland the wells have to be sunk to a considerable depth. One of the circumstances, which tend to maintain the water supply in the coast basin is that the rainy seasons above and below the Ghâts do not coincide. In illustration of this, Capt. King mentions that he saw the Taknota river, when in a state of flood, discolouring the sea to a distance of more than a mile, although no rain had fallen near the coast for some months.

The specimens collected by Capt. King have been examined, and slides for the microscope prepared from the most interesting.

Igneous Rocks. (1.) *Porphyrite.*—This rock, of a dingy-brown, containing porphyritic felspars, chiefly plagioclase, and other crystals possibly pseudomorphs after pyroxene, gives good illustration of the replacement of felspar. Granular epidote has developed, generally from the heart of the crystal, and forms pale-green patches, well marked even in the hand specimen. In one felspar, there is a fan-shaped group of chlorite; apatite crystals are also present, one of which seems to have been corroded by intruding portions of the ground-mass.

(2.) *Hornblende-Diabase.*—The crowded crystals of large green hornblende are very dichroic, giving high tints with crossed Nicols (purples and reds), but they pass by a gradual transition to lighter-coloured less dichroic patches within, and thus recall the more abrupt variation from brown to green hornblende in the Little Knott rock.[1] It would seem that a secondary change has attacked the mineral, but has not completely spread over the interior. There is a tendency to an orientation in the hornblende cleavages, and the crushed and schistose structure of the rock may well be the result of pressure, which has acted on what was possibly once a gabbro.

(3.) *Granite.*—This granite, whose locality is not given, may perhaps have occurred in association with the metamorphic rocks of the valleys, and may contribute to the fragmental quartz, which is said to be so abundant there. The felspar is chiefly microcline; and, included both in it and in the quartz, is a dark green metallic-looking mica, so small in amount that the rock is almost a binary granite.

[1] Q.J.G.S. 1885, vol. xli. p. 512, pl. xvi. fig. 2.

In the quartz, along continuous surfaces, are rather large fluid cavities with moving bubbles. The granite seems somewhat disintegrated; the quartz grains, and, at places, the felspar, are coated with a bright red deposit. Some of this ferruginous substance appears under the microscope minutely pisolitic, and the small concretions are sometimes banded concentrically like spherulites.

Metamorphic Rocks. (1.) *Gneisses.*—One specimen is a white micaceous gneiss, with small garnets. From the appearance of the rock, Professor Bonney has suggested that it may possibly have been once igneous, although there is now an evident foliation, and the gneiss has suffered contortion since the foliation was acquired.

In a pale red or flesh-coloured gneiss, the quartz is ranged in streaks very suggestive of the action of pressure. The felspar is mainly plagioclase, with possibly some microcline, and either exhibits a kaolinized condition, or seems to pass to a clear mineral with lines like the distinctly marked cleavages of kyanite, suggesting the possibility of the formation of clear pseudomorphs similar to those noticed by Prof. Bonney.[1] White mica seems to have developed in places at the expense of the felspar.

A banded hornblendic gneiss contains hornblende, which is very dichroic and possibly of two varieties. It is replaced in the paler bands of the rock by brown mica, associated with quartz, and also with felspar, which may be partly kaolinized along certain of the twinned laminæ. Small irregularly formed garnets occur, salmon-pink in colour, within a cloud of kaolinized substance and associated with flakes of biotite, as if they had formed from original felspathic material by the addition of iron and magnesia, while the brown mica was developed in connection.

(2.) *Talc Schist.*—This specimen seems to have been artificially cut, as if the rock may be used as a kind of potstone. Under the microscope, the slide exhibits an interfelted mass of talc, together with a pale apple-green mineral, which is sometimes very dichroic, and would agree with prochlorite in its softness. Some magnetite occurs, and a reddish iron glance in such quantity that the section has a brownish colour. The chlorite has much the appearance of a pseudomorphous formation after some mineral, very probably biotite, and it helps to give the orientation of the slide. The foliation appears to have undergone subsequent disturbance, amounting to a crumpling and even an approach towards an "ausweichungsclivage."[2]

(3.) *Epidote Schist or Epidosite.*—Said to occur near the foot of the hills, and it would probably belong to some part of the earlier series of rocks, which form the foundation of the higher ground. The specimen consists mainly of epidote, the quartz being probably not more than 10 per cent. of the whole rock. The epidote is mostly granular, but some of it is in larger crystals, which exhibit cleavage. The quartz grains are drawn out in the direction of the general orientation and sometimes ranged, almost in single file, in thin parallel bands. A few small crystals of hornblende occur.

[1] Q.J.G.S. 1878, Pre-Carb. Rocks of Charnwood, part ii. p. 215, note.

[2] "An advanced stage of minute puckering, some or all of the surfaces of contrary flexure having become shear-planes." (*Teall's Petrography*, p. 424.)

(4.) *Quartzite.*—This is formed of very well rounded grains cemented by crystalline silica, and is thus similar to the specimen recently described by Professor Bonney from near Ightham.[1] The cement consists mainly of crystals projecting outwards, and ranged in successive layers, which are separated by dusty lines. The wider interstices are filled in, towards the interior, by clear chalcedonic granules, the deposit being sometimes completed in the centre by a brown opaque material. The grains of the quartzite are mostly simple, but sometimes composite, and they contain rutile-like needles, and lines of cavities with moving bubbles. The quartz may appear very dirty, or it may contain only few enclosures, but in several examples these cease along a narrow marginal zone, which, therefore, probably represents siliceous cement deposited in crystalline continuity with the original grains.

Sedimentary Rocks. 1. *Grits and Sandstones.*—One specimen of sand, which consists of well rounded grains, is labelled "red earth used for dyeing." The quartz grains are large, and are coated with ferruginous deposit, and seem thus not unlike the red sands of the Arabian Desert described by Mr. Phillips.[2] Fragments which are more angular form the constituents of a coarse, claret-coloured grit, and of a very strong brown sandstone, which was obtained from Mount Eilo, and is probably the one mentioned as suitable for grindstones. In all the sands and grits, the quartz is more or less coated with a ferruginous substance, which is not unfrequently a kind of pisolitic deposit, similar to that described in the granite. In some of the specimens there are quartz pyramids connected with the grains, which recall the appearance of the additive crystals figured by Mr. Phillips.[3] Besides quartz, the slides contain fragmental felspar, often plagioclase, also films of brown mica, and occasionally a hornblende or tourmaline fragment or a garnet.

2. *Limestones.*—The lithographic stones, as well as other of the limestones, have a very compact character, as is illustrated also by a specimen from the floor of Eilo cave, "polished by the passage of animals over it." (1.) From Mount Eilo. This pale buff-coloured limestone is as compact in character, but has the appearance of a fissile structure. It is in a partially crystalline condition, but with much admixture of earthy material. This limestone, and some of the lithographic stone with most marked conchoidal fracture, yielded only slight traces of fossils, but in slides prepared from two specimens, organic remains were well able to be identified, although they were less clear in one of the two rocks, which appeared to have undergone greater dolomitization. These slides, with my conjectures as to the identification of the fossil forms, were submitted to Prof. Rupert Jones, and the following is a list modified in accordance with the opinion he kindly expressed.

(2.) Limestone, fourteen miles south of Bulhar. This contains

[1] Geol. Mag. July, 1888, Figure on p. 299.
[2] Q.J.G.S. 1882, vol. xxxviii. p. 111.
[3] Q.J.G.S. 1881, vol. xxxvii. "On the Constitution of Grits and Sandstones," pl. ii. figs. 1, 2, 3, 5.

many obscure Foraminifera, such as *Amphistegina* (?); and there are also remains of Polyzoa (?).

(3.) Limestone from Eilo. The slides of this rock exhibit:—Fragments of Lamellibranch shells, of Polyzoa, of (?) a plate of an Echinoderm, and Gorgonia-like spicules.

Foraminifera:—*Lagena*, *Globigerina*, *Textularia* (common), *Planorbulina*, *Rotalia*, *Miliola*, sections of specimens having affinities (?) with *Miliolina*, and rather *Trochammina*-like in form.

The general facies of this fauna is characteristic of late Cretaceous and of Tertiary formations, but if the forms doubtfully identified as *Amphistegina* belong to that genus, its occurrence, fairly abundant, would rather suggest that the limestone may be of Miocene age, and thus possibly contemporaneous with that of Socotra.[1]

From certain miscellaneous specimens, we may infer that flint and chert, containing traces of organic remains, were formed in connection with the calcareous rocks. The deposition of a ferruginous material is everywhere emphasized in sands and grits, in the coating of larger pebbles, and in irony concretions, recalling the description of a neighbouring locality where the ground was said to look as if strewn with iron slag.[2]

The district, illustrated by these rock fragments, is evidently one in which the foundations of the hills are composed of gneisses and schists, which are laid bare in the valleys, possibly in association with granite. Among these rocks, there are evidences of the action of pressure, and thus, in the higher ranges further inland, this gneissic series may be raised to a greater elevation and may form a larger part of the mass, as in the place where Sir F. Burton describes walls of rock full of glittering mica.[3] The central massif would be concealed beneath gently stratified sedimentary beds. Some of these are grits and sandstones, which mark the results of a denudation of older crystalline rocks, others are limestones, sometimes Foraminiferal.

The crystalline series is found to the eastward, as shown in the sections from Somali Land published by Dr. A. T. de Rochebrune[4] from notes brought back by M. Révoil, and still further eastward in the Island of Socotra.[5] Northward, similar rocks occur in Abyssinia[6] and Egypt, and in the peninsula of Sinai. Sandstones and limestones have a similarly wide extension, although further evidence is needed to fix the exact age and correlation of these formations in the Eilo district. Some of the sandstones seem, lithologically, rather like those which Dr. Rochebrune compares with the older sands of Nubia and of Adigrat; the overlying calcareo-argillaceous rocks he identifies by their fossils as of Neocomian age. Thus the rocks, described in this note, vary in some details from those of neighbouring localities, yet bear out, on the whole, the inference of Professor Bonney as to the wide extension which has characterized former geological conditions in North-eastern Africa.

[1] Phil. Trans. 1883.
[2] "First Footsteps in Africa," p. 391.
[3] "First Footsteps in Africa," p. 395.
[4] Faune et Flore des Pays Çomalis, G. Révoil, 1882 (Observ. Géol. Dr. A. T. de Rochebrune).
[5] Phil. Trans. 1883.
[6] Geology and Zoology of Abyssinia, W. T. Blanford.

VII.—Note on *Eurypterus* from the Carboniferous.

By Henry Woodward, LL.D., F.R.S., V.P.G.S.,
of the British Museum (Natural History).

In the Geological Magazine for November last (Decade III. Vol. IV. p. 481, Pl. XIII.) I gave a brief description of a new species of *Eurypterus* from the Lower Carboniferous Shales, Eskdale, Scotland, which I named *Eurypterus scabrosus*.

I referred to other Carboniferous forms, and briefly mentioned one from the Lower productive Coal-measures, Darlington, Pennsylvania, U.S.A., figured as a *woodcut* only in the American Phil. Soc. Proc. vol. xix. p. 152, 1881.

I was not aware at that time that my friend Professor James Hall, of Albany, had printed a "Note on the *Eurypteridæ* of the Devonian and Carboniferous Formations of Pennsylvania." [Extracted from Report of Progress PPP, Second Geological Survey of Pennsylvania. 8vo. with six plates, Harrisburg, 1884; *printed in advance.*]

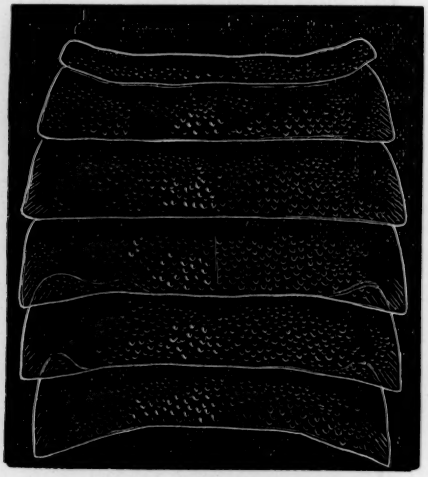
Having, through the kindness of the author, been favoured with a copy of this memoir, I hasten to remedy the omission in my paper referred to above, and to state that Professor James Hall has fully described and figured this Coal-Measure *Eurypterus* from Darlington under the name of *E. Mansfieldi*. Both in the form of its appendages and its size *E. scabrosus* is quite distinct from Hall's *E. Mansfieldi*, the latter being not more than nine inches in length, whereas the former measured, when perfect, probably not less than 20 inches. *E. scabrosus* was, moreover, furnished with long and slender bluntly-spinose appendages, but in *E. Mansfieldi* the palpi terminated in sharp recurved spines, closely resembling the earlier U. Silurian forms both in its palpi and swimming-feet.

Prof. James Hall devotes 24 figures to the illustration of this species; he also figures and describes three others (*E. potens*, *E. stylus*, and *E. Pennsylvanicus*) from the same locality and formation as *E. Mansfieldi*. *E. stylus* is a much smaller form, only about half the length of the former. *E. Pennsylvanicus* is only known by a detached carapace, and *E. potens* by some detached portions. Professor James Hall also adds an important note on *Eurypterus* (*Anthraconectes*) *Mazonensis*, Meek and Worthen, from the Coal-measures of Grundy Co., Illinois (see Amer. Journ. Sci. vol. 46, p. 21, 1868: also Geol. Surv. of Illinois, vol. iii. (Geology and Palæontology), 1868, p. 544, woodcut figure). This, as Hall very correctly points out, is no doubt a true *Eurypterus*, and the slight differences pointed out by Messrs. Meek and Worthen do not seem to justify the placing it in a distinct genus.

Prof. Hall figures a second specimen from Mazon Creek, which he believes to be *the actual counterpart* of Meek and Worthen's specimen, and points out how closely it agrees in many respects with *E. Mansfieldi*, the differences being really only of specific value.

The same author also figures and describes a very complete but headless body of a *Eurypterus* from the Chemung group (Upper Devonian) of Warren, Pennsylvania (plate iii. p. 30, op. cit.), which

he names *E. Beecheri*.[1] From the presence of parts of two long slender, ridged, non-spinose appendages associated with the body in the position which would have been occupied by the swimming-feet, I am led to surmise that this may possibly prove to belong to the genus *Stylonurus*; but I offer this suggestion with extreme caution and reserve, well knowing the great care and vast experience of Prof. James Hall in dealing with this group of ancient Merostomatous Crustacea.



Body-segments of *Eurypterus Wilsoni*, H.W. (natural size), Coal-measures, Radstock, Somerset.

Before concluding this note, I desire to call attention to a very interesting discovery made by Mr. Edward Wilson, F.G.S., of the Bristol Museum, of a part of the body of a *Eurypterus* (see woodcut) from the true Coal-measures at Ludlow's Pit, Radstock, Somerset.

The specimen consists of the first six body-segments only, following immediately behind the head: they measure together 53½ millimètres in length by 52 mm. in greatest breadth. The first segment, as is constantly the case, is shorter than any of the others, being only 4½ mm. deep; the 2nd is 8 mm.; the 3rd 11 mm.; the 4th, 5th, and 6th are each 10 mm. deep. The first segment is nearly straight and 42½ mm. broad; the segments gradually become more arched, and increase in breadth slightly to the 4th, which is 52 mm. broad; contracting slightly to the 6th segment, which is 47½ mm. broad. The 1st, 2nd, and 3rd segments have their lateral borders nearly straight, but the 4th, 5th, and 6th are rather more expanded and the posterior angles are produced and rather more pointed. The surface of each segment is marked by squamæ which are extremely numerous and very minute along the anterior border of each segment, but near

[1] See also Natural History of New York, Palæontology, vol. vii., by James Hall (with supplement to vol. v. part ii.), 1888, pl. xxvii. fig. 5, p. 156 (just received).

the centre and at the lateral angles these scale-markings become much larger, more acutely pointed in shape, and more irregularly distributed.

These scale-markings agree exactly with those of *Eurypterus Mansfieldi* (Hall), as represented by Prof. Hall on an enlarged scale (see plate v. fig. 6, *op. cit.* p. 38), but the margins of the segments of the Radstock specimen are hardly so pointed at their latero-posterior angles as the American species above quoted. The proportions are about equal to the largest example recorded by Prof. Hall.

In the absence of the rest of the organism, it would be premature to speak confidently; but, as it will probably prove to be a distinct British species, but near to *E. Mansfieldi* of Hall, I would propose to name it provisionally *Eurypterus Wilsoni*, after its discoverer.

NOTICES OF MEMOIRS.

Cambrian Fauna in Estland.

Ueber eine neuentdeckte untercambrische Fauna in Estland. Von F. Schmidt. Mit zwei Tafeln. (Mem. de l'Acad. des Sciences St.-Pétersbourg, vii^e^ série, tome 36, 1888, pp. 1–28, pls. i. ii.)

HITHERTO the Cambrian strata of the Russian Baltic provinces have proved so exceedingly poor in fossils, that it has not been possible to make a satisfactory comparison between them and the relative beds in Sweden and elsewhere. Below the *Dictyonema* shales, which are analogous to the beds of the same name in Norway and Sweden, there occurs the *Unguliten* or *Obolus* sandstones; and beneath these are beds of blue clay with subordinate layers of sandstone, which rest upon Finland granite, and have been proved by borings to reach 600 feet in thickness. The upper portions of the blue clay series in Estland were regarded by Linnarsson in 1872 as equivalent to the *Eophyton* sandstone of Sweden, and the main mass of the *Unguliten* sandstone as representing the Fucoid sandstone of the same country; but at that time no fossils were known which could substantiate these views. Lately, however, thanks to the persevering efforts of M. Mickwitz, an engineer of Reval, the fragmentary remains of a characteristic fauna have been discovered in the upper beds of the blue clay series at Reval and the neighbourhood, which fully confirm Linnarsson's opinions. The fossils which have been carefully described and figured by F. Schmidt in the present paper are *Olenellus Mickwitzi*, n. sp., *Scenella discinoides*, n.sp., *S.? tuberculata*, n.sp., *Mickwitizia* (*Obolus*?) *monilifera*, Linnars. sp., *Obolella* (?) sp., *Discina* (?) sp., *Volborthella tennis*, n. gen. et sp., *Platysolenites antiquissimus*, Eichw. sp., *Medusites Lindstrœmi*, Linnars. sp., *Primitia*?, *Cruziana*, and *Fræna tenella*, Linnars.

The *Olenellus Mickwitzi* comes in at a lower stage than the *O. Kjerulfi*, and is thus the oldest Trilobite known in Europe. Its occurrence at this horizon confirms the views of Linnarsson, Holm, and Brögger, that the *Olenellus* zone is distinctly older than that of *Paradoxides*.

The following table is given by the author to show the equivalents of the Cambrian strata of the Baltic provinces with those of Norway and Sweden.

Baltic.	Sweden.	Norway.
Dictyonema-shale	*Dictyonema*-shale	*Dictyonema*-shale.—2e
Unguliten-sand		
	Olenus-zone	*Olenus*-zone 2d, 2c, 2b, 2a
	Paradoxides-zone	*Paradoxides*-zone 1d, 1c
	Olenellus-zone.	
	Zone of *O. Kjerulfi*	Zone of *O. Kjerulfi*.—1b
Fucoid-sand	Fucoid-sandstone.	
Zone of *Olen. Mickwitzi*	*Eophyton*-sandstone	
Blue Clay		Sparagmit-stage 1a
Lower Sandstone		

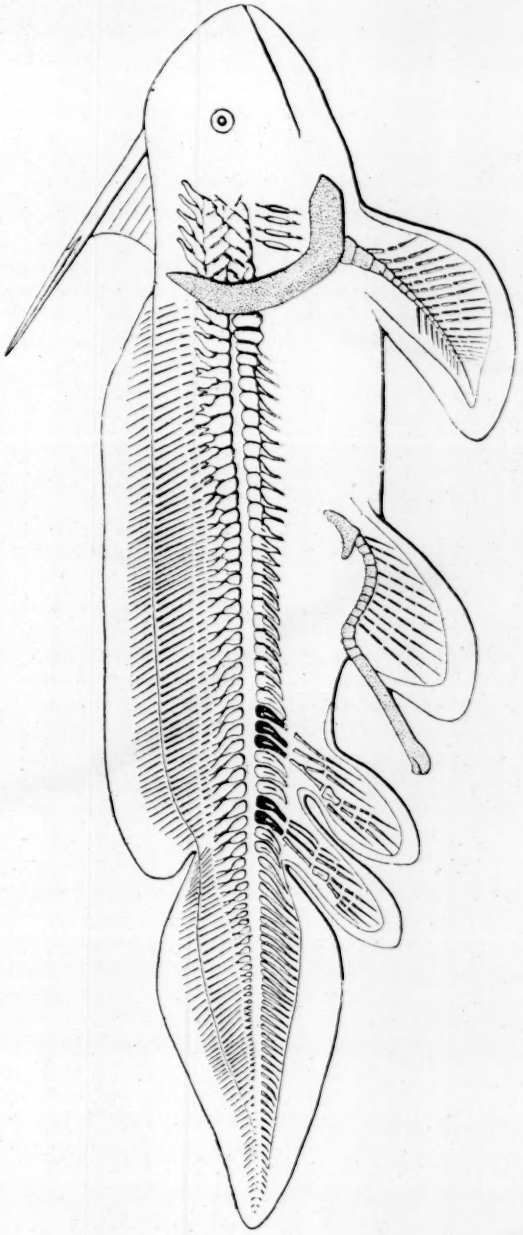
Fr. Schmidt thinks that the Baltic *Olenellus* zone is equivalent to the lower part of the St. John's group in North America, and to the lowest stages of our Harlech and Longmynd groups, in which no Trilobites have as yet been found, whilst the *Dictyonema* shales and the *Unguliten* sand may be paralleled with the Lingula Flags.

REVIEWS.

I.—M. Charles Brongniart on *Pleuracanthus*.[1]

THE precise characters of the extinct cartilaginous fishes, whose detached teeth and spines have long been known under provisional names, are now becoming gradually revealed through the progress of research; and no more interesting and important discovery has been made of late than that of the complete trunk of *Pleuracanthus*, described last April by M. Charles Brongniart, of the Paris Museum of Natural History. Through the kindness of M. Brongniart we are enabled to present the accompanying woodcut, which is a restoration of the skeleton of the fish, based upon no less than twenty-three examples of a new species (*Pleuracanthus Gaudryi*), from the Coal-measures of Commentry, Allier, France. The known individuals vary in length from 0·45 m. to 1 m., presumably owing only to their differences in age; the skeleton is always well displayed, being calcified as in Selachians, while the skin is destitute of shagreen. The body is elongate in form, and the snout obtuse. The notochord is persistent, and the bases of the neural and hæmal arches expanded; the slender neural spines bifurcate distally in the greater part of the abdominal, and the anterior half of the caudal, region. The pectoral fin, as already pointed out by Goldfuss and Anton Fritsch, is a biserial archipterygium; and each of the pelvic fins in the male is provided with a robust clasper, as in Chimæroids and Selachians. The barbed spine is placed upon the head, and forms the anterior border of a small "cephalic" fin; and a long dorsal fin commences almost

[1] "Sur un nouveau Poisson fossile du terrain houiller de Commentry (Allier)," Comptes Rendus, April 23rd, 1888.



Restoration of Pleuracanthus Gaudryi, Brongniart.

From the Coal-measures, Commentry, Allier, France.

Brongniart & Sobier del.

immediately behind, sharply separated from the upper half of the elongated diphycercal caudal, to the commencement of which it extends. But most singular and novel are the two small representatives of the anal fin, which are "placed one behind the other and have the appearance of true limbs. Narrow at their base, they enlarge mesially, and then become contracted. Their skeletal framework is almost identical. The hæmapophyses supporting them are truncated instead of ending in a point. The first two hæmapophyses bear very slender interspinous elements which are in connection each with a fin-ray. The third is larger, broad at its extremities, supporting distally a shorter broader ossicle. From this are detached, above a ray, and below two short ossicles, of which the first supports an ossicle and fin-ray, and the second two ossicles and two fin-rays. We find nothing comparable in nature, fossil or recent." It may also be added that Dr. Anton Fritsch will be able to make known interesting confirmatory—perhaps supplementary—evidence upon these points, when the Bohemian Pleuracanths are described, the writer of the present notice having been favoured with an inspection of beautiful examples in Prague.

The completed memoir on this important discovery has yet to appear, but M. Brongniart remarks, at the conclusion of the preliminary note, that, as the result of his studies, *Pleuracanthus* must be regarded as representing at least a distinct order, perhaps a sub-class, the "Pleuracanthides,"—"a group ancestral to, and connecting, the Dog-fishes, Cestracionts, Rays, Chimæras, Sturgeons, and *Ceratodus*." It is to be hoped, however, that before proposing any new term, the author will consider in more detail the conclusions of previous workers in the same direction. Prof. Cope has already placed a member of the group in a distinct order, the "Ichthyotomi," equivalent in value to the order of Selachii; and although Mr. Garman remarks, apparently with much reason, that the definition originally proposed (relating to so-called distinct traces of ossification in the chondrocranium) is very doubtfully accurate, all recent researches have tended towards as complete an isolation of the *Pleuracanthus*-like fishes as now seems inevitable. Dr. Traquair's description of the genus *Chondrenchelys*, with the appearance of a splint-like bone (? parasphenoid) upon the chondrocranium, and with complete broad vertebral rings in the caudal region, will likewise require consideration; and the same author's discovery of a uniserial archipterygial pectoral fin in *Cladodus* seems to the writer of this notice to place that much-discussed genus also in the great Pleuracanth order. The archipterygial character of the pectoral fin will certainly become one point in the broad diagnosis of the group, although, it must be admitted, a few Selachii (e.g. *Squatina*) exhibit some faint approach to that condition; and it cannot be said that the form of the teeth will count of much value, for the depressed and posteriorly expanded character of the base in the teeth of *Cladodus* is precisely paralleled in some Notidanidæ and undoubted Hybodonts, which are true Selachii. It has hitherto been too much the custom to regard every ancient fish, destitute of membrane bones and

possessing dermal structures of vascular dentine, as a member of the Selachian order; and the results of M. Brongniart's researches upon the exquisite examples of *Pleuracanthus Gaudryi* will be anxiously awaited, on account of the valuable new light they are destined to shed upon such questions.

A. Smith Woodward.

II.—Contributions to the Palæontology of Brazil; comprising Descriptions of Cretaceous Invertebrate Fossils, mainly from the Provinces of Sergipe, Pernambuco, Para, and Bahia. By Charles A. White. With Portuguese Translation by Orville A. Derby. 4to. pp. 273, and 28 Plates. (Extracted from vol. vii. of Archivos do Museo Nacional do Rio de Janeiro.)

THE fossils described by Dr. White were collected some years since by the Brazilian Geological Survey under the direction of the late Professor Hartt, from low-lying rocks of sandstone, limestone, and shale, occurring in several disconnected areas bordering the Brazilian coast, from the mouth of the Amazon southwards. These rock-basins are open towards the sea, but landwards are bounded by higher ridges of crystalline, and probably Palæozoic, strata. Some of the deposits in the neighbourhood of Bahia are of freshwater origin. Both marine and freshwater beds are referred by Dr. White to a Cretaceous age, since the majority of the typical fossils from them are characteristic of this period, and some are identical with undisputed Cretaceous fossils of other regions. But with these fossils occur others of a distinct Jurassic aspect, though not specifically identical with any known Jurassic species, and, again, these are mingled with Gasteropods belonging to *Fusus*, *Murex*, *Phorus*, etc., which, if occurring alone, would have been referred to the Tertiary period. Judging by the Mollusca, the author finds this Brazilian fauna more nearly related to the Cretaceous fauna of Southern India than to any other yet known, and next after this, it approaches the fauna of the Gosau beds in the Tyrol. The freshwater Mollusca from the Bahia beds are likewise peculiar, since the species (of which 11 are described) belong to recent types.

There are 82 species of Conchifera (Lamellibranchiata) described, most of them new; the best represented families are the Ostræidæ, Limidæ, Pteriidæ, Arcidæ, Crassatellidæ, Cardiidæ, and Anatinidæ. Of Gasteropoda, 91 species have been determined, 77 of which are regarded as new; the Naticidæ, Cerithiidæ, and Fasciolariidæ are the most numerously represented families. A single new species of Polyzoa, *Lunulites pileolus*, closely resembles the *L. annulata*, Stol., from the Cretaceous of Southern India. There are 13 species of Cephalopoda, which, with the exception of a form of *Helicoceras* and one of *Nautilus*, belong to the Ammonitidæ. Fourteen species of Echinoderms are described, with one exception they are regarded as new.

All the new species, and some others as well, are carefully illustrated in the accompanying plates, and a good index is

appended. It may also be mentioned that the author gives, at the beginning of the work, a bibliographical list of publications on the invertebrate Mesozoic fossils of South America. The list only includes 24 titles, and thus indicates the slight amount of work which has hitherto been done on this group of fossils within the bounds of this continent. We note one omission; that of a short paper by Prof. E. Forbes on the Secondary fossil shells from South America, given as an appendix to Part II. of Darwin's "Geological Observations."

III.—Allgemeine Geologie, von Dr. Karl v. Fritsch, Professor an der Universität in Halle. Mit 102 Abbildungen. Bibliothek Geographischer Handbücher. Herausgegeben von Prof. Dr. Friedrich Ratzel. (8vo. pp. 500.) Stuttgart, Engelhorn, 1888.

IN Germany, not less than in England, new manuals of Geology, and new editions of old ones, appear with a frequency which indicates a considerable amount of interest, both on the part of students and of the public generally in the science of which they treat. The present volume by Prof. von Fritsch is brought out as one of a series of Geographical handbooks, and there can be no doubt of the importance of a thorough acquaintance with the facts and principles of geology to any one who aims at a real knowledge of geography. This book seems to be well adapted for its purpose; though necessarily it covers the same ground as other manuals of the science, the subject is treated from an independent point of view, and the author may justly claim that it is not a mere compilation, but has been based on his own study and observation of the facts. The following is the arrangement adopted in the work:—I. Geophysiography; II. Geotectonic or Stratigraphy; III. Geochemie or Chemical Geology, including Petrography and Lithology; IV. Geomechanic or Physical Geology; and V. Geogenie or Historical Geology. The facts and deductions relating to each of these divisions are stated very clearly and concisely, and the work may be commended, not merely to beginners, but to students of Geology generally. G. J. H.

IV.—Salt-Range Fossils. By William Waagen, Ph.D., F.G.S. I. Productus-Limestone Fossils: 6. Cœlenterata, Memoirs of the Geological Survey of India, 1886, pp. 835–924, plates xcvii–cxvi.

IN this elaborate memoir the Corals of the Carboniferous Limestone of the Salt-Range of the Punjab are described in detail, and illustrated on a scale which might give rise to the envy of non-official palæontologists, who have to be content with figures of much humbler proportions. These Corals are, for the most part, of the same general characters as those of the Devonian and Carboniferous strata of this country and North America. They belong to the genera *Aræpora*, *Pachypora*, *Michelinia*, *Monotrypa*, *Orbipora*, *Geinitzella*, *Stenopora*, *Lonsdaleia*, *Amplexus*, *Hexagonella*, *Dybow-*

skiella, and *Fistulipora*. Of these, *Geinitzella*, *Hexagonella*, and *Dybowskiella* are proposed as new, but their characters are so similar to those of *Stenopora*, *Evactinopora*, and *Fistulipora* respectively, that the author might well have spared the introduction of the new names. A very important feature in the description of these Corals is the way in which their minute structures have been investigated by means of microscopic sections, of which several hundreds were prepared by Mr. Wentzel, the colleague of Prof. Waagen in the authorship of this memoir. A comparison of the beautiful figures given of these sections, with those of nearly allied forms which have appeared in the papers of Prof. Nicholson and Mr. Foord, fully shows the value and absolute necessity of basing the determination of these and other Corals on their minute structural characters. In the interpretation of some of these minute structures, the authors of this memoir differ considerably from Prof. Nicholson; but we are inclined to think that, as regards the nature of the wall in the axial corallites, the view of Prof. Nicholson, that it is really double, better accords with the facts, than the explanation that it is single, and that fracture really takes place between it and the subsequently deposited layers of stereoplasm. Further, the evidence seems insufficient to establish the statement that the spinous structures in many of the Monticuliporidæ, the Acanthopores of Nicholson, are merely the young stages of the ordinary corallites. Other points, on which somewhat dogmatic opinions are given, are likewise open to criticism; but we must content ourselves with an expression of satisfaction that these organisms have been so thoroughly and carefully investigated and described; so that this memoir is a refreshing contrast to some of the earlier publications of the Indian Survey, in which the superficial features of the Corals merely have been noticed. A tabular statement of the species described in the memoir would have increased its value and convenience for reference.

G. J. H.

CORRESPONDENCE.

THE ATMOSPHERE OF THE CARBONIFEROUS PERIOD.

Sir,—May I be permitted one word on a question which has been raised as to the greater prevalence of carbonic acid in the atmosphere of this earth in the Carboniferous Period than at later periods, if only to suggest that Prof. Prestwich and his critic seem to be arguing at cross-purposes? There is no reason why both statements should not be true. The real question would then be, as to what would constitute "an excess of carbonic acid." There is some confusion of thought as regards such two essentially different physiological functions of plant-life and growth as *respiration* and *assimilation* of *carbon*. This is hardly excusable when we need go no farther than the most trustworthy elementary books (such as those in the London series), to be informed of the essential difference of these two processes, and of necessity of free oxygen for the activity of protoplasm in the plant and animal alike. On general grounds therefore

we should expect that a moderate increase (beyond the mere four parts in 10,000 of our present atmosphere) of the food-stuff (carbonic acid) of plants would be favourable to more rapid production of vegetable tissue; and on the same grounds we should equally expect that such an increase of the same gas, as to practically asphyxiate plants, would be fatal to them. But between the two limits there is ample room for Prof. Prestwich's hypothesis, which is probably well founded.

Why not experiment on the question? It is easy enough.

Sachs (*Lehrb. d. Botanik*, p. 692) states that "experiments on plants (Vegetationsversuche) show that growth and the changes of material necessarily associated therewith only take place in the tissues (of plants) so long as free oxygen has access to them: in the absence of free oxygen (in einer saüerstofffreien Atmosphäre) no growth takes place; and if plants remain a longer time in such an atmosphere they die."

If, however, the percentage of carbonic acid in the present atmosphere were multiplied, say 100-fold, its volume would still be less than one-fifth that of the free oxygen present. This we should scarcely expect to reach the asphyxiation-proportion for plants. The above quotation is from the Leipzig edition (1874) of Sachs' great work. It is probable that in the recent new edition much fuller information is to be found.

Wellington College, Berks. A. Irving.
4th May, 1888.

OBITUARY

PROF. HENRY CARVILL LEWIS, M.A., F.G.S.

Born November 16th, 1853; Died July 21st, 1888.

Amongst the many and varied ties which serve to bind America and England together in friendly union, there are probably none more sincere and reciprocal than those which subsist between the scientific men of the two countries.

As Englishmen we take the warmest interest in the grand development of that wonderful country "on the other side," and the hearty reception given to our American cousins here is returned with equal or even greater warmth by them, whenever we visit the New World.

It is doubtless owing to their greater energy and enterprise that Americans are by far the more frequent visitors to our shores than are we to theirs. This is no doubt largely due to the historical attractions which an old country always offers to a new one, and also the desire to compare our scientific work and institutions with their own.

No one amongst the many young scientific Americans of note has more earnestly cultivated English and European methods of research, or has worked with greater enthusiasm to carry his geological investigations from North America into Britain, than the subject of this brief memoir, Professor Carvill Lewis. H. C. Lewis was

born in Philadelphia, November 16th, 1853, being the son of Mr. F. Mortimer Lewis and Emma Hulme (Carvill) Lewis, of that city. At the age of 20 he graduated B.A. with first honours in Classics at the University of Pennsylvania, taking his M.A. degree in 1876. He took a post-graduate course of three years in Natural Science, and between 1879 and 1884 he served as a volunteer on the staff of the Geological Survey of Pennsylvania; investigating at first the surface-geology of Southern Pennsylvania, and afterwards the Glacial phenomena of the Northern part of that State. Here he succesfully traced the great terminal moraine of the North American Ice-sheet from New Jersey to the frontier of Ohio. During this period he contributed a number of papers to the Academy of Natural Sciences of Philadelphia upon the mineralogy and geology of Pennsylvania.

In 1880 he was elected Professor of Mineralogy in the Academy of Natural Sciences, Philadelphia, and in 1883 he was appointed Professor of Geology in Haverford College, Pennsylvania, U.S.

In 1882 Prof. Carvill Lewis married Miss Julia C. Foulke, daughter of the late Mr. W. Parker Foulke of Philadelphia, a man of varied attainments and wide scientific interests.

Between 1885 and 1888 he was engaged in studies and original investigations in Europe; the winters being spent in Heidelberg, where he worked at microscopic petrology and crystallography, under the guidance of Prof. Rosenbusch, and the summers in the field tracing out the difficult and complex problems connected with the Glacial Epoch in Great Britain and on the Continent.

Here he had completed a map of the ancient glaciers and ice-sheets of England, Wales and Ireland, which was exhibited and discussed at the British Association, Birmingham, 1886; Manchester, 1887; and elsewhere.

He had also commenced similar studies in Switzerland and North Germany. These, however, were interrupted by a visit to America, where he contracted typhoid fever, which developed in a sudden and alarming manner immediately on his return to England, and terminated fatally on July 21st, at Manchester.

Prof. Carvill Lewis was a Fellow of the Geological Society of London; of the Geological Society of Germany; a Member of the American Philosophical Society; of the Academy of Natural Sciences of Philadelphia; the Franklin Institute; the American Association; a Corresponding Member of the British Association; and a Member of the Geological Society of Liverpool.

It is always sad to see a bright young life suddenly cut short in early manhood, but it is more especially so when, as in the case of Prof. Carvill Lewis, such good work had been already done, and we had abundant promise of a splendid future scientific career.

Over and above all this Prof. Lewis had such a happy, bright and genial manner, that he readily won for himself the warm regard of a very wide circle of friends, whilst among men of science he seemed to give sure promise of a long life of solid and valuable work. His loss will be keenly felt both in America and Europe, not only amongst geologists, but men of science generally.

The following are amongst his more important papers :—

"On Philadelphite, a new Mineral Species." (Proc. Acad. Nat. Sci. Philadelphia, 1879.)
"The Optical Characters of some Micas." (Proc. Acad. Nat. Sci. Philadelphia, 1880, pp. 244-251.)
"Siderophyllite, a new Mineral." (Proc. Acad. Nat. Sci. Philadelphia, 1880, pp. 254-255.)
"The Surface Geology of Philadelphia and its vicinity." (Journ. Franklin Institute, 1880.) (Proc. Acad. Nat. Sci. Philadelphia, 1880, pp. 258-272.)
"The Trenton Gravel and its relation to the Antiquity of Man." (Proc. Acad Nat. Sci. Philadelphia, 1880, pp. 296-300.)
"The Iron-ores and Lignites of Montgomery Co. Valley." (Proc. Acad. Nat. Sci. Philadelphia, 1880, pp. 282-291.)
"A New Fucoidal Plant from the Trias." (Proc. Acad. Nat. Sci. Philadelphia, 1880, pp. 293-294.)
"Some Enclosures in Muscovite." (Proc. Acad. Nat. Sci. Philadelphia, 1882, pp. 311-315.)
"An American Locality for Helvite." (Proc. Acad. Nat. Sci. Philadelphia, 1882, pp. 100-102.)
"Pseudomorphs of Serpentine after Dolomite." (Proc. Acad. Nat. Sci. Philadelphia, 1882, pp. 36-38.)
"The Great Terminal Moraine across Pennsylvania." (Proc. Amer. Assoc. Adv. Sci. Montreal, 1882.—*Science*, 1883, vol. ii. pp. 163-167.)
"On a Supposed Human Implement from the Gravel at Philadelphia." (Proc. Acad. Nat. Sci. Philadelphia, 1883, pp. 40-43.)
"Phosphorescent Variety of Limestone." (Proc. Acad. Nat. Sci. Philadelpia, 1884, pp. pp. 10-12.)
"Report on the Great Terminal Moraine across South-Eastern Pennsylvania and Western New York, 1884, pp. 299, maps, sections. and photograhs.
"On Supposed Glaciation in Pennsylvania South of the Terminal Moraine." (Amer. Journ. Sci. 1884, vol. xxxiii. pp. 276-288.)
"Erythrite, Genthite and Cuprite from near Philadelphia." (Proc. Acad. Nat. Sci. Philadelphia, 1885, pp. 120-122.)
"Marginal Kames." (Proc. Acad. Nat. Sci. Philadelphia, 1885, pp. 157-173.)
"A Great Trap Dyke across South-Eastern Pennsylvania." (Proc. Am. Phil. Soc. 1885, pp. 438-456.)
"Comparative Studies upon the Glaciation of North America, Great Britain, and Ireland." (GEOL. MAG. 1887, Ser. III. Vol. IV. pp. 28-32.) British Assoc. Reports, Birmingham, 1886.
"On a Diamantiferous Peridotite" and "The Genesis of the Diamond." (Brit. Assoc. Rep. Birmingham, 1886.) (GEOL. MAG. Ser. III. Vol. IV. 1887, pp. 22-24.) (*Science*, vol. viii. 1886, pp. 345-347.)
"The Terminal Moraines of the Great Glaciers of England." (British Assoc. Reports, Manchester, 1887.) (Amer. Journal Science, 1887, ser. iii. vol. 34, p. 402.)
"On some extra-Morainic Lakes in England, North America, and elsewhere during the Period of Maximum Glaciation, and on extra-Morainic Boulder-clay." (British Assoc. Reports, Manchester, 1887.) (GEOL. MAG. 1887, p. 515.)
"On the Matrix of the Diamond." (Brit. Assoc. Reports, Manchester, 1887.) (GEOL. MAG. 1888, p. 129.)
"The Terminal Moraine of the Irish Sea Glacier near Manchester." (Brit. Assoc. Reports, Manchester, 1887.)

THE TERMINAL MORAINES OF THE GREAT GLACIERS OF ENGLAND.

NOTE.—Mrs. Lewis desires to state that, after the meeting of the British Association at Manchester last year, Prof. Carvill Lewis set out in company with herself and Dr. H. W. Crosskey, of Birmingham, to visit and examine Frankley Hill, in Worcestershire, the only alleged deposit of glacial "Till" south of the great Moraine line which he had not seen prior to the Manchester meeting. Here an excavation was made, under Prof. Lewis's superintendence, through the gravel to a depth of from eight to ten feet; thence the party traced the few detached Arenig boulders to the frontier of Wales. Prof. Carvill Lewis then said that for the first time in all his experience, both in the old and new world, he had found unmistakeable evidence of a glacier, between which and the Glacial Epoch there was as vast an interval of time as between that and the present day. It was the intention of the late Prof. Lewis to make a thorough re-examination of all England, lest a similar deposit elsewhere might have escaped his notice; but now that his labours have been so suddenly brought to a close, Mrs. Lewis thinks this statement should be put on record.—H.W.

AMOS H. WORTHEN.

PALÆONTOLOGIST AND GEOLOGIST.

BORN OCTOBER 31ST, 1812; DIED MAY 6TH, 1888.

AMOS H. WORTHEN, a son of the late Thomas Worthen, was born at Bradford, Orange County, Vermont. He commenced life as a Schoolmaster in Harrison County, Kentucky, but in June, 1836, he removed to Warsaw, Illinois, where he spent the remainder of his life. While engaged in business, he became interested in the science of Geology, and made a large collection of fossils, and also of those remarkable geodes of the Keokuk limestone in that region.

On the institution of the Geological Survey of Illinois in 1851, under Prof. J. G. Norwood, he was appointed his Assistant, which post he filled for four years. From 1855 to 1857 he was Assistant to Professors James Hall and J. D. Whitney on the Geological Survey of Iowa, and the volume published in 1858 owes much of its value and interest to the labours of Mr. Worthen. The many beautiful plates of this large volume are from drawings by Mr. F. B. Meek, who was afterwards associated with Mr. Worthen in the palæontology of his own Reports.

In March, 1858, Mr. Worthen was appointed by the State to the charge of the Geological Survey of Illinois, which position he occupied till 1872, when he became Curator of the Illinois State Museum.

The seven completed volumes of the Geology and Palæontology of Illinois form the best and most lasting monument to his memory. Mr. Worthen left an eighth volume in the press. Besides these voluminous reports, he issued a large coloured geological map of Illinois, and three volumes on the Economical Geology of the State. He was also the means of gathering for the State Museum one of the largest and best collections of fossils in the country.

In the early part of the Survey Mr. Worthen encountered and overcame great opposition. His modesty and earnestness, high character and quiet dignity, gave him great influence, and the many difficulties disappeared before him. Although nearly 75 years of age at his death, he had not given up work; the preparation of the text and plates illustrating the Silurian Invertebrate fossils of Illinois, for the eighth volume, was occupying him, when a sudden attack of pneumonia brought all to an end.—*Silliman's American Journal*, August, 1888.

WILLIAM HELLIER BAILY, F.L.S., F.G.S., M.R.I.A.

PALÆONTOLOGIST AND GEOLOGIST.

BORN JULY 7, 1819; DIED AUGUST 6, 1888.

WE regret to announce the death, at Rathmines, near Dublin, of Mr. W. H. Baily, who, after a lingering illness, passed away on August 6, at the age of 69. The greater portion of his life was

devoted to Palæontology, and most of the fossils which he described, and those which illustrated his works, were drawn on wood or stone by his skilful hand.

Mr. Baily was born at Bristol on July 7th, 1819, and he inherited artistic talent, for both his grandfather and father, as well as his uncle, Edward Hodges Baily, R.A., were remarkable for their carving and sculpturing. He began his scientific career in 1837 as Assistant Curator in the Bristol Museum, resigning this post in 1844, when he was attached to the Geological Survey of Great Britain as Draughtsman. In the following year he was appointed to the staff as Assistant Geologist under Sir Henry De la Beche. His duties, however, were confined to the Museum work, and in 1854 he was styled Assistant Naturalist, serving for a time directly under Edward Forbes, and afterwards under Professor Huxley. In 1857 he was transferred to the Irish branch of the Geological Survey, as Acting Palæontologist, and he retained this post till the close of his life. In 1868 he received the additional appointment of Demonstrator in Palæontology to the Royal College of Science for Ireland.

Mr. Baily was the author of many papers on palæontological and kindred subjects, and his labours will be best shown by the list of his works, which amount to 43 in number. His most important private work was that published in parts from 1867 to 1875, being Figures of Characteristic British Fossils: with descriptive remarks. Unfortunately, the work did not sufficiently recompense the author from a pecuniary point of view, and after the first volume was published, completing the Palæozoic portion, it was abandoned. In 1867 he received the proceeds of the Wollaston Donation-fund, awarded by the Geological Society of London, in aid of this work. His official labours comprised Palæontological Notes in the Explanatory Memoirs to the Maps of the Geological Survey of Ireland, and the list of these alone would be a lengthy one.

Mr. Baily, like the late Prof. Morris, and Mr. J. W. Salter, with whom he was a contemporary and a fellow-worker, belonged to that small body of Geologists and Palæontologists, now, alas! nearly all passed away, who possessed an extensive general knowledge both of rocks and fossils, and also the invaluable ability *to draw*, as well as to describe, what they saw and studied, whether in the field or in the cabinet. These men can never be replaced by our modern student-specialists.

Personally Mr. Baily was of a genial disposition and his loss will long be felt by his friends and colleagues.

ERRATA.—Please make the following corrections:—GEOL. MAG. March No. p. 123, in footnote, line 2, for "Memoir" read "*Meunier.*" In May No. p. 240, line 33 from top of page, for *the work which* Mr. Lee *has actually done*—read "the work which *we see* actually done."—In August Number, p. 382, line 3 from bottom, for *lavas* read *laws.*—EDIT. GEOL. MAG.